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EMPIRE COTTON GROWING CORPORATION

REPORTS RECEIVED FROM
EXPERIMENT STATIONS

1926-1927

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STATIONS, 1926-1927**

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CONTENTS

AUSTRALIA:

QUEENSLAND:

	PAGE
BILOELA STATION	7
REPORT OF COTTON ENTOMOLOGIST	35

AFRICA:

UNION OF SOUTH AFRICA:

BARBERTON STATION	49
CANDOVER STATION	66

SWAZILAND:

BREMERSDORP STATION	83
-------------------------------	----

SOUTHERN RHODESIA:

INTRODUCTORY NOTE	105
GATOOMA STATION	106

ANGLO-EGYPTIAN SUDAN:

SHAMBAT STATION	134
---------------------------	-----

UGANDA:

SERERE STATION	177
--------------------------	-----

NYASALAND:

INTRODUCTORY NOTE	189
MAKWAPALA STATION	190
PORT HERALD STATION	216
REPORT OF COTTON ENTOMOLOGIST	231

NIGERIA:

DAUDAWA SEED FARM	234
-----------------------------	-----

FIJI:

SIGATOKA STATION	240
----------------------------	-----

PREFACE

THE present volume of Reports from Experiment Stations is the third that the Corporation have issued. It contains reports from ten Stations and from the Corporation's Seed Farm in Nigeria, together with the reports of the Corporation's Cotton Entomologists in Australia and Nyasaland.

Among a mass of important work, which even in these early days is beginning to bear fruit, attention might perhaps be directed to the variety trials on rain-grown cotton at present being conducted under Mr. Bailey's supervision in various parts of the Southern Sudan, where the Sudan Government is patiently laying the foundations of what it is hoped will one day prove a mighty industry.

The repetition under Southern Rhodesian conditions of the Barberton work on Jassid attack is also interesting. It is to be hoped that it will be attended by the same measure of success that has marked Mr. Parnell's efforts in the Transvaal.

Experiments at some Stations have been hampered by climatic conditions alike unfavourable and abnormal, notably in Swaziland, at the Candover Station in Natal, and in Uganda. Where necessary the work will be repeated.

The first paper from the Corporation's Research Station in Trinidad is about to appear in the *Annals of Botany*. A summary of it was included in the *Empire Cotton Growing Review*, vol. iv., No. 4, together with a short account of other work that is being carried out there.

QUEENSLAND

REPORT ON THE WORK OF THE CALLIDE COTTON RESEARCH STATION, BILOELA, FOR THE YEAR ENDING JUNE 30, 1927

BY

W. G. WELLS.

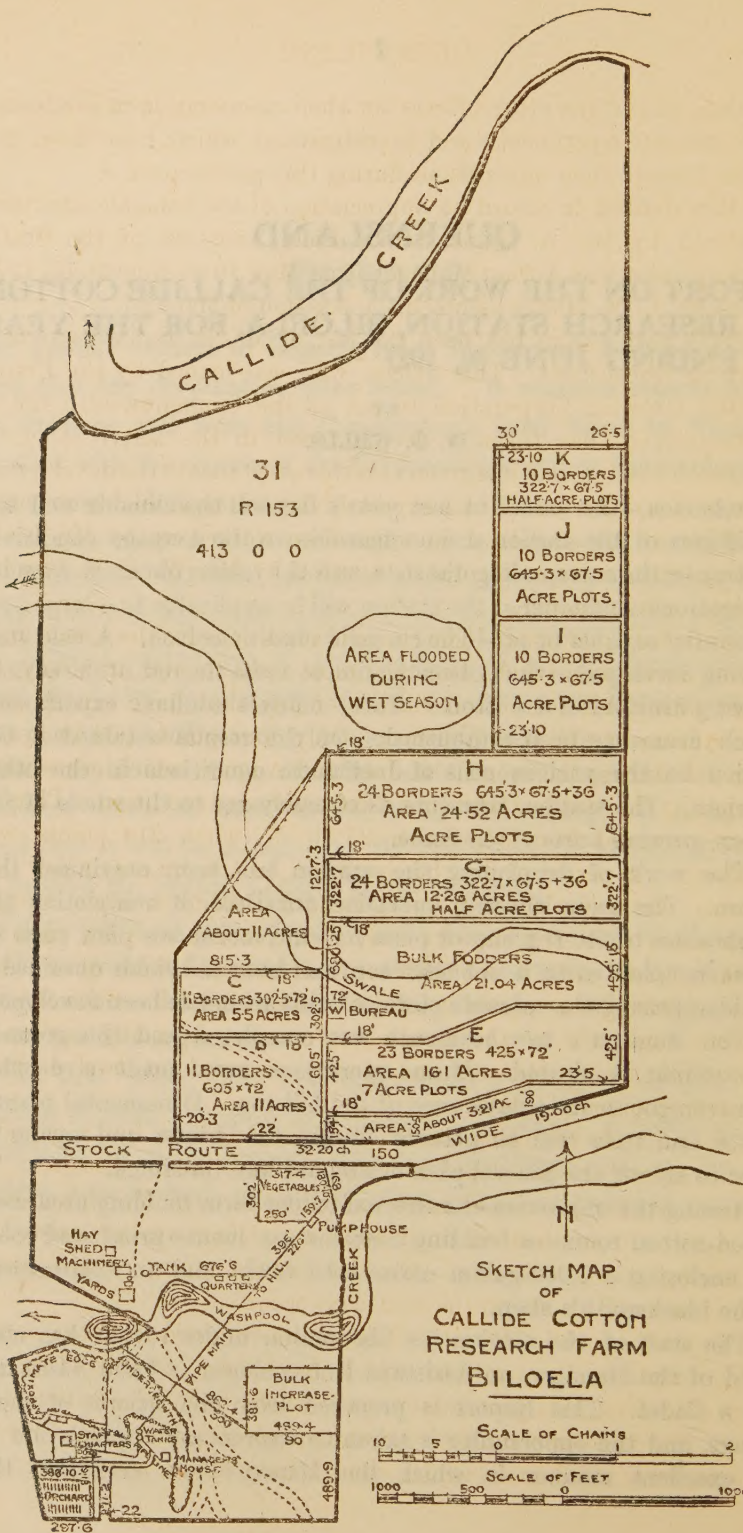
Introduction.—As stated in last year's Report, the climatic and soil conditions of the station are comparable to the average conditions existing in the surrounding districts, and the results obtained from investigations conducted at the station will be applicable to a large area of country capable of producing a good class of cotton. A field staff is being developed in the Cotton Section to assist the rest of the cotton-growing districts in the State. These officials conduct experiments which demonstrate the application of the results obtained at the station to the various soils and climatic conditions in the other districts. The station, therefore, is of assistance to the whole of the cotton-growing areas of the State.

The work of developing the station has been continued this season. The main clearing operation consisted of completing the preparation of the D group of plots for cultivation (see plan, page 8). Maize was planted on it as a test crop, and from the yields obtained it would appear that a valuable piece of cultivation has been developed.

The Manager's new residence was completed and the grounds surrounding it cleared. These operations have made a decided improvement to the appearance of the hill-top. Ornamental plants, shrubs and trees will be planted during the winter and spring in order to set off the general plan of orchard and buildings.

Among the improvements effected in the farm building area were a seed-cotton room—a building containing a mouse-proof seed room and enclosing a 1,000-gallon maize seed tank—and an enlargement of the blacksmith's shop.

The staff of the station for the season under review has consisted of the Manager, an Assistant Entomologist, a Field Assistant, and a Cadet. This Report is prepared from the reports of these officers, and the opportunity is taken to express my appreciation of the excellent manner in which the Manager has conducted the



station, and to the other officers for their co-operation in conducting the various experiments and investigations which have been performed under their supervision during this past season.

It is desired to record an appreciation of the valuable assistance rendered by Mr. A. Nagle, Senior Field Assistant of the Cotton Section, who was Acting Manager from May 10 to August 16, 1926, when Mr. L. M. Hodge assumed the position of Manager.

This past season has been the last of Mr. E. Ballard's term of duty in Queensland. This officer, who was loaned by the Empire Cotton Growing Corporation to act as the Commonwealth Cotton Entomologist, has taken a deep interest in the activities of the Research Station, and has given valuable assistance to the development of it. It is regretted that his expert advice will be available no longer.

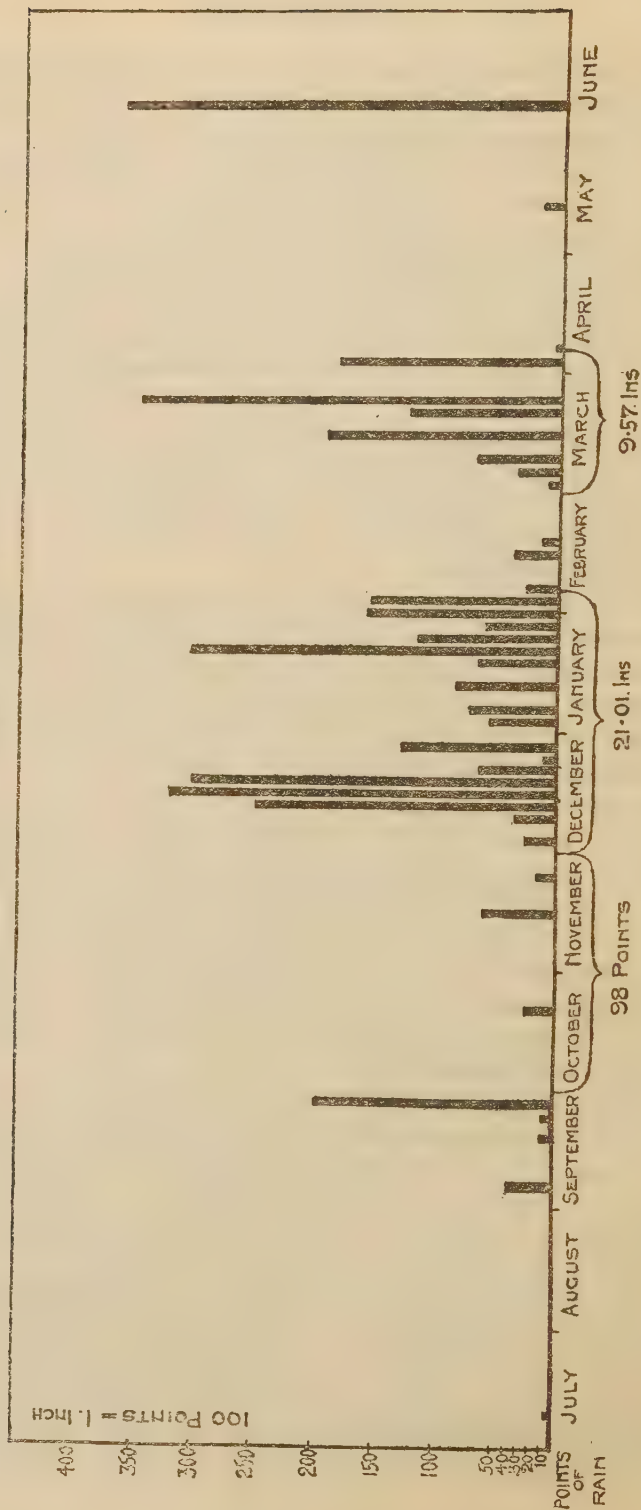
Most of the statistical data has been worked up by Mr. R. W. Peters, Cotton Experimentalist, assisted by Mr. W. A. R. Cowdry, Junior Cotton Grader.

Seasonal Conditions.—The climatic conditions for the season under review have, as a whole, been the most variable and, in a way, the most unsuitable for cotton culture of any that have existed since the station has been established. Only four points (.04 inches) of rain fell during the months of July and August, which necessitated preparing the seed bed while in an extremely dry condition. Planting rains occurred from September 25 to 27, when 214 points were received. A period of dry, hot weather, broken by only a few light storms, was experienced from then until December, when, starting with a few scattered showers early in the month, the dry spell was broken finally with a splendid series of storms lasting over eleven days. During this period a total of 9.55 inches fell. Showery conditions continued in the month of January, especially during the latter part, when showers and storms occurred on twelve out of thirteen consecutive days.

Fortunately the rains slackened off in February, but a period of high temperatures developed which would have proved disastrous had it not been for a series of rains extending through March and early in April. From then on until June 4 excellent weather existed for maturing the cotton crop. On this date a storm of 310 points, followed by 53 points on the next day, occurred.

Operations under Review.—The results obtained from the various experiments and operations which have been conducted on the station during this past season, as a whole, have been satisfactory, when the climatic conditions are taken into consideration. Experiments were conducted which should have given very interesting

SEASON: 1926-27. RAINFALL CHART. BILOELA.



results under such climatic conditions as have been experienced in former seasons, but unfortunately, the unusual seasonal conditions have affected many of the experiments in such a way as to make it impossible to obtain any clear-cut results; wherever possible, however, observations were made on the behaviour of the crops under the different treatments. These are included in the Report, not as representing accurately obtained data, but with the idea of affording some information as to the season's results. In future analyses of the results obtained over a series of years it is possible that such observations as are now included will prove of value.

Cotton.—The yields obtained from most of the cotton plots, with the exception of the eastern half of the J group, are considered satisfactory for such conditions as prevailed this season. The soils were so dry at the time of ploughing that great difficulty was experienced in preparing a suitable seed bed. Fortunately a fall of 214 points of rain wetted the soil so thoroughly that a good surface soil mulch could be obtained at the time of planting. Splendid germinations were experienced in all plots, but the lack of subsoil moisture soon checked the development of the seedlings.

Little further growth was made until the occurrence of the December rains. From then on, owing to the frequent rainfall which was experienced during that month and January, a very rapid and sappy vegetative growth was developed. This growth was accompanied by a heavy setting of squares, but only light flowering. A decided check to this development occurred during the period from February 18 to 25, when a cool spell occurred, during which a maximum temperature of 81.4° on the 23rd and a minimum temperature of 53° on the 24th were experienced. This period was followed by several days in which high maximum and minimum temperatures predominated. The effect of such extremes in temperature, in conjunction with a lowering soil moisture content, was to stop the increase in the setting of the squares and to cause an increase in the percentage of shedding. The growth of the structure of the plant was also affected, as shown by the short internodes at the corresponding sections of the main stalk and the fruiting branches, which were developed during this period. On light sandy patches of soil a complete cessation of the development of the fruiting branches occurred. As was to be expected, the flowering increased rapidly during the period of high temperatures and continued until the occurrence of the rains from March 12 to 25. Rapidly falling minimum temperatures from then on checked any further heavy flowering.

The rains occurring during March, while checking the flowering, came at very opportune times. Owing to the sappy condition of the plants prior to the dry spell in February a serious check was being experienced due to the period of forty days without rainfall of any amount; sufficient rain fell in March, however, to carry the crop on to maturity.

An excellent class of fibre, which was of better body and greater strength than the average of previous seasons, was produced over most of the plots. The maturing of the crop occurred at least two months later than the usual time, owing to the fact that there was no bottom or lower middle crop, on account of the peculiar structure of the plants. Unfortunately a very heavy storm of 363 points fell on June 4 and 5, which caused a considerable amount of staining, thereby lowering the grade of an appreciable proportion of the station's crop.

During the first half of November, 1926, a most serious loss of terminal buds occurred. In several plots the buds at the node of the cotyledons were destroyed, with a resultant development of abnormally large cotyledons of an extreme thickness. In such cases great difficulty was experienced in obtaining anything approaching a perfect spacing of the stand for each treatment. In other plots a good spacing was obtained at the time of thinning, but subsequent loss of the terminal buds when the plants were 8 to 12 inches high destroyed much of the value of the experiments. During the periods of heavy rainfall in December and January the plants without the main terminal buds developed a most astonishing system of vegetative branches. Many specimens were obtained where 8 to 12 such branches developed from a section of the main stalk of only 5 to 8 nodes in length. As the growth of the main stalk had been stunted to a point at which the internodes were of much less length than is normally the case, the occurrence of so many large basal limbs and small extra-axillary branches gave the plants a most unusual appearance. The explanation of this phenomenon could not be determined. Very close inspection for insect attack was maintained through the period. Grasshoppers, in particular, were suspected, but the population present was so small as to make it extremely doubtful whether they were doing heavy damage. Careful inspection of the affected plants also failed to show evidence of insect attack. In most cases the small bud appeared to have withered off.

Soil surveys were made to determine if the loss was caused by a lack of moisture. In some plots it appeared that this might be the case, but no definite evidence could be obtained. Certainly in some

plots where the subsoils were of a heavier texture, and therefore more able to hold the moisture up to the roots of the seedlings, less damage occurred. This was especially true in a neighbouring cotton field where the clayey soils developed practically normal plants, but on one side of this field, which was composed of a splendid loam of good depth, a large percentage of the plants were of the misshapen type. Unfortunately, under similar soil conditions in some of the cotton plots in other parts of the State, the phenomenon was apparently as marked on the clayey soils as on the loamy soils. Generally speaking, the clayey soils throughout the State produced a higher percentage of normal plants than did the loams. Nothing definite, however, could be determined as to the cause of the severe loss.

The bulk of the crop on the station was planted during the first part of October, and therefore could be classed as an early planted crop. The delayed development of the plants, however, until the occurrence of bountiful rains in December, and their abnormal structure, resulted in a growth more nearly resembling late November planted cotton. The results obtained from the various plots, therefore, may not be classified as being exactly indicative of those usually obtained from cotton planted on the same date and grown under more normal conditions.

Cotton Experiments.—Most of the cotton experiments which are being conducted at the station deal with problems which require the repetition of the experiments over a series of seasons before any conclusive results can be anticipated. In describing the results of several of the experiments a description of the method and general reasons for the experiment have been omitted. Such experiments are marked with an asterisk (*) to indicate that they have been described more fully in the Annual Report of the Station for 1925-26.

Fallowing Experiment.—The general experience of growers in most of the cotton-growing areas in Queensland has been that early planting is desirable, both from the point of view of producing a crop, and also as affording immunity from attacks of the Corn Ear Worm (*Heliothis obsoleta*). Where a grower has a large acreage of cotton, it is not possible always to remove the old stalks and get the land ready in time to prepare a seed bed which will allow an early strike to be obtained and maintained. In most of the cotton-growing districts planting rains usually fall in September, but unfortunately the month of October may be very dry. When such conditions occur, the cotton plants on land which grew cotton the previous season often experience losses through the seedlings dying from lack of subsoil moisture.

The results obtained on the farms of the more progressive growers,

and on the Research Station, all indicate the advisability of preparing the seed bed as early in the winter as possible. It has been thought that possibly the best method by which to obtain an early prepared seed bed would be to grow cotton in combination with a summer fodder crop. This would allow the seed bed for the cotton crop to be ploughed in the late summer, and thus obtain the full value of any winter rains which might occur.

It was accordingly decided to carry out experiments to ascertain the value of the following cropping schemes:

A cotton crop following a cotton crop.

A cotton crop following a summer fodder crop.

A summer fodder crop following a cotton crop.

In the first cropping scheme, the old cotton crop will be removed and the land ploughed at about the time that the average grower in the district performs these operations—*i.e.*, in late July or during August. A cotton crop will be planted after the first proper rains. During the winter following the maturing of this crop, the seed bed will be prepared for a summer fodder crop, etc.

In the second cropping scheme, the cotton crop will be planted on a seed bed which has been fallowed from April of the previous season. Such a seed bed will have received the full benefit of any rains which may have fallen during the winter. Even in the event of no rains having fallen, ample time will have elapsed to have allowed the seed bed to firm considerably.

In the third scheme, a fodder crop will be grown following two seasons of cotton crops. This crop may be planted early in the season if proper weather conditions occur, in which case two cuttings may be obtained. If the planting conditions are not favourable until the December rains occur, one heavy cutting will be obtained. In either case, the crop will be removed and the land ploughed in April if conditions are at all favourable.

The following table shows the data in connection with the plots of the different cropping schemes of this season:

	<i>Date of Ploughing.</i>	<i>Number of Harrowings.</i>	<i>Previous Crop.</i>	<i>Date of Planting.</i>	<i>Rate per Acre Yield.</i>	<i>Remarks.</i>
Scheme 1	Aug. 5	3	Cotton	Oct. 7 (Cotton)	844½ lbs.	Ploughed April 4 and disc- harrowed.
Scheme 2	June 28	4	Sudan Grass	Oct. 6 (Cotton)	787 lbs.	
Scheme 3	July 12	4	Cotton	Oct. 12 (Fodder)	2.23 tons dry weight	

The actual weights obtained from the two cotton plots show a difference in favour of the cotton following cotton. In reality, the yields of the two plots were about the same. The plants in the crop on the long fallowed seed bed bore a much heavier bottom crop, and under the conditions of the season much of this was lost through boll-rot disease or through the pickers failing to lift the tangled masses of vegetative branches to get to the lower bolls. The plants in the cotton following cotton scheme bore most of the crop on the upper parts of the main stalk or on the fruiting branches near the ends of the vegetative branches. This facilitated picking, which resulted in a greater percentage of this crop being harvested.

The same abnormal development of vegetative branches occurred in these two plots as was experienced over the rest of the station; the results, therefore, cannot be taken as being indicative of a more normal season. The fact that the plants in the long fallowed plot bore a heavier bottom crop would indicate that an increased resistance to dry weather conditions was afforded early in the season. The winter months of 1926 were characterized by exceptional lack of rain, as is shown by most of the winter fodder crops on the station having failed to produce anything approaching normal yields. This prevented a thorough preparation of the seed bed, although the extra time of fallow undoubtedly allowed the seed bed to firm to better advantage than did the late ploughed one.

In the season 1924-25, an experiment was conducted in which crops on adjacent plots were compared. One plot had been fallowed throughout the winter, while the other had been prepared early in the spring, following a cotton crop. The resultant yields were 1,364 lbs. and 775 lbs. respectively, a difference of 589 lbs. in favour of the crop on the long fallowed land. The climatic conditions of that season were anything but favourable for cotton-growing, a total of only 18.32 inches of rain having fallen during the growing season (October to March). In addition, a prolonged and severe heat wave in February caused excessive shedding and reduction in the size of the bolls.

The above series of three cropping schemes will be carried on for several seasons, as it is only over a long period that any definite results may be expected from such a complex problem. It has been demonstrated that early prepared seed beds offer the best assurance of obtaining profitable yields. The question arises as to whether the fodder crop—Sudan grass—is that best suited for rotation with cotton. It is believed that some system of rotation will have to be practised, otherwise the fertility of the soils will be depleted. This phase of the problem is being studied in a series of crop rotations. It

may be found that some other fodder crop is better suited for use in this experiment. The possibility also may exist that a crop rotation, in which a season is devoted to green manure crops, may offer the most profitable method with which to maintain the fertility of the soils.

Time of Planting Experiment.—This experiment suffered badly from the effects of the unfavourable climatic conditions, so that only the early October and the late December plantings were obtained. The first planting, while entitled to be called an early planting, in reality developed more in the nature of a mid-November planting. The lack of subsoil moisture soon checked the growth of the plants, which in many cases lost their terminal buds. When the heavy rains occurred in December a very forced growth developed which continued unchecked until the latter part of the dry spell in February. Heavy shedding of squares and young bolls occurred at the end of this dry spell. Owing to the lack of main stalks and the excessive vegetative branch development, practically all of the crop was borne on the fruiting system of the upper parts of the large basal limbs, which resulted in a very late crop being produced; 1071.5 lbs. per acre were produced, however, which is more than a November-planted crop would have produced under similar conditions.

The late December-planted plot failed to produce sufficient crop to warrant picking it. An estimate of the number of matured bolls gave a count of 1.3 bolls per plant. This plot was not planted until the 22nd of the month owing to lack of rainfall. Heavy rains occurred soon after planting, so that thinning was necessary on January 10, the plants averaging 6 inches in height. The continuation of the excessively wet conditions forced a very rank development of the plants, which bore a medium crop of squares. Heavy shedding from insect attack and climatic conditions occurred, so that no control was afforded over the development of the plants in the rainy period in March. The early occurrence of frosts on May 6 and 17 completely checked any further development of the plants.

The results obtained from late December plantings on the heavier soils in the Callide and Dawson Valleys are of extreme interest in connection with this experiment. The soil in the station plot varies from a medium loam to a sandy clayey mixture, and little difference of growth was obtained over the plot. On the heavy clayey soils, however, the continuous rains apparently made the soils so sodden as to prevent the proper aeration. The "physiological drought" effect caused by such conditions produced a most marked effect on the plant. Instead of a rank elongated plant such as occurred in the December plot on

the station, a most compact ideal type of plant of small to medium height was developed. Splendid crops of good quality fibre were borne on such plants, which enabled large numbers of growers to obtain profitable returns. The occurrence of such results, when the experiences of the previous seasons would indicate slight chances of obtaining them, opens up the possibility of some interesting investigations. Several of these have been arranged for the coming season.

Table of Yields in Time of Planting Experiment.

Season 1924-25.

October 7 planting	..	..	912 lbs. per acre.
November 10 planting	..	..	885 " " "
December 19 planting	..	..	220 " " "
January 15 planting	..	..	Not picked; failed to mature.

Season 1925-26.

No October planting.*			
November 5 planting	..	..	933 lbs. per acre.
December 15 planting	..	..	116 " " "

Season 1926-27.

October 2 planting	..	..	1,071½ lbs. per acre.
December 22 planting	..	..	No yield; failed to mature.

Some insect attack was experienced in the plot planted in October, but of small amount as compared with that occurring in the mid-December plot. The same comparative freedom from insect attack, especially the Corn Ear Worm (*Heliothis obsoleta*), was experienced in the rest of the October plantings on the station and throughout the farming districts in the surrounding valley. Similar results have been obtained each season in this respect, and it appears that early planting, especially when accompanied by early development of the plant, offers a reliable insurance against the possibility of corn ear worm attack. This, in connection with the fact that early planted crops offer the best chances of obtaining heavy yields, makes it all the more important that the growers should prepare the seed bed in time to plant on the first good rains which fall after the temperatures are favourable for obtaining good germination.

Wet versus Dry Seed Planting Experiments.—In cotton-growing countries where the rainfall may be of erratic occurrence at planting time, the problem of obtaining a good strike over large-sized acreages in some seasons is somewhat difficult. It has been the custom on the Research Station to soak the seed in warm water for any plots in which the surface moisture was considered to be insufficient to

* No October planting was obtained in the experiment. Plantings in mid-September on the station produced from 922 to 1,473 lbs. per acre.

insure a good germination. Good results have always been obtained from such a procedure. It was decided to conduct an experiment during this past season to determine the relative value of this and the ordinary method of planting. In combination with this feature of the experiment, the testing of the method of planting in open furrows as compared to drill planting was also included.

In some of the older settled districts, where the farmers have maize planters which are not adapted to planting cotton, the custom has been to plough open shallow furrows and distribute the seed by hand along the bottom of the furrows. The seed is covered by the use of one-horse scufflers which are narrowed so as to tear down the sides of the furrows. This leaves a low shallow depression, and the point arose as to whether this was of any benefit as a protection against winds when the plants were in the seedling stage. It was also considered that possibly the depression would collect extra moisture around the seed in the event of light rains falling early in the plants' growth.

Briefly the experiment was as follows:

Four rows: Dry seed drilled in by ordinary cotton planter.

Four rows: Soaked seed drilled in by ordinary cotton planter.

Four rows: Dry seed distributed by hand in bottom of furrows and covered with one-horse scuffler.

Three rows: Soaked seed distributed by hand in bottom of furrows and covered with one-horse scuffler.

The seed was soaked by the following method. A wash-tub about one-third full of water was nearly completely filled with seed. The contents were heated until a temperature of 105° F. was obtained, after which they were stirred frequently and kept heated to a temperature around 100° F. from 6.30 a.m. until 10 a.m. The seed was then planted, the planting rate in the drilled rows being 30 lbs. to the acre in order to ensure that ample uncut seed would pass over the distributing cogs of the planting machine.

The date of planting was October 4, and on October 10 the rows in the drills which had been planted with soaked seed had an 80 per cent. strike, while only a few plants were showing in those sown with the dry unsoaked seed. In the furrows approximately the same percentage of germination had been obtained with the soaked seed, but no plants were showing in the furrow rows planted with the dry seed. Twenty-four hours later, a good stand was present in the dry drills and about a 5 per cent. stand in the dry furrows. On November 6, the stand was estimated at 95 per cent. for the wet drills and furrow rows and the dry drills, but gaps in the stand, of 8 feet in width,

were present in the dry furrows. Unfortunately only 23 points of rain fell during the period from October 10 to November 6, so no chance was afforded of studying the moisture-collecting properties of the furrows. Owing to the poor stand obtained in the dry furrow, and also to the incidence of cutworm attacks, the experiment was abandoned.

It would appear from the results of the experiment that planting seed which has been soaked in the manner described enables a good germination to be obtained when conditions for planting dry seed are unfavourable. Germination occurs at least twenty-four hours earlier when the soaked seed is used. When planting by the furrow method, soaked seed enables a quicker and better germination to be obtained than where unsoaked seed is used. It is pointed out, however, that soaked seed should not be planted if there is danger of the soil moisture quickly drying out below the seed. In such cases the young roots start developing, and then die for lack of moisture. Planting dry unsoaked seed is preferable in such cases, as no germination will start. The seed will remain sound, and any occurrence of showers or light rains will cause a quick germination to be effected. It is also advised that the seed should be planted on the day it is soaked, because if it be left over night there may be danger of the process of germination being arrested, which might cause the rotting of the seed after it was in the ground.

**Direction of Rows Experiment.*—A modification of last season's experiment was continued this season—i.e., spacings between the plants of 12, 18, and 24 inches were tested in conjunction with the direction of the rows. The blocks were planted alternately north-south and east-west. An exceptionally good crop was produced, the yield for the whole border being at the rate of 1,890 lbs. per acre, which is the highest recorded to date for the station. Fortunately only a small percentage of the plants in the various plots were affected by loss of the terminal bud. This allowed a comparison to be made of the effect of the various spacings on the different portions of the fruiting structure of the plants. Generally speaking, most of the plants in the wider spacings were of the standard B type of plant which is being developed in the breeding plots on the station.

Unfortunately the prolonged dry period following planting affected the stand obtained in the experiment, so that the results are not indicative of the spacing which they represent. The table on p. 20 shows the results and the amount of deviation from the correct number of plants.

Direction of Rows.	Spacing of Plants.	Mean Weight in Lbs. of Two Total Pickings.	Mean Weight in Lbs. First Picking.	No of Plants.	
				Correct.	Actual.
East and west	12 ins.	12.4 $\pm$.30	7.83 $\pm$.29	66	50.8 $\pm$.95
	18 "	11.2 $\pm$.46	7.66 $\pm$.36	44	42.3 $\pm$.25
	24 "	13.16 $\pm$.44	7.66 $\pm$.30	33	32.0 $\pm$.58
North and south	12 "	13.38 $\pm$.30	8.4 $\pm$.30	66	52.4 $\pm$ 1.4
	18 "	12.9 $\pm$.32	7.1 $\pm$.29	44	37.3 $\pm$.62
	24 "	13.5 $\pm$.28	7.2 $\pm$.34	33	32.7 $\pm$.74

With such an error occurring in the number of plants, an accurate comparison of the results for the stated spacings cannot be obtained. It would appear, however, that the direction of rows had little, if any, effect on the growth of the plants. In the 24-inch spacing, which was fairly accurate in both treatments, there was only a difference of .34 lbs. $\pm$.486, which is not significant. The 24-inch spacing in both treatments bore a better bottom crop per individual plant than did the plants in the other two spacings, but the greater number of plants in the 12-inch spacing gave that spacing a tendency to produce a slightly higher yield for the first picking; the difference was not significant, however. It is possible that with a more perfect spacing this distance might have given a significant difference.

Only a small amount of boll rot appeared, and in about equal amount for each spacing. Some shedding occurred throughout the plots during the dry spell in February, but of equal degree in both treatments.

The experiment is being repeated in the coming season, but with only a comparison of the 24-inch spacing, as this appears to give the best results for most soils. It is believed, however, that the grower need not consider the question of the direction of the rows. Such factors as the contour of the land and the length of the rows are of more importance, and are thought to be of more economic value under Queensland conditions.

**Height of Thinning and Spacing Experiment.*—This experiment is becoming of more importance each season, owing to the tendency in several of the districts to increase the size of the individual acreage. The farmers are becoming more accustomed to cotton-growing, and are finding that they can cultivate larger acreages of cotton with the more efficient machinery which they are now purchasing. This increasing of the size of the acreage immediately brings up the problem of thinning of the crop. With the smaller acreages, the grower and

his family could complete the whole of the thinning before any serious damage was done to the plants. The increased acreages will necessitate the employment of labour, and the question arises as to how much hired labour will be required. By knowing the limits in height to which the plants may grow before any ill-effect from delayed thinning will be experienced, the grower will be in a position to estimate how much extra labour he will require with his increased acreage.

The experiment of this season was planned similarly to that of last season, with plants spaced 15 and 24 inches apart, and thinned when 4 to 6, 10 to 12, and 14 to 16 inches in height. The same difficulty in obtaining a perfect stand was experienced in this experiment as in the others at the station. Loss of terminal buds and fatalities during the dry weather following planting reduced the stand to such an extent that the results in the 15-inch spacings are not representative of that distance. They are included, however, as they afford an opportunity of indicating the effect on the yield of the closer spacings under such climatic conditions as existed this season.

In habit of growth, the malformed plants in the 15-inch spacings showed a tendency to send their vegetative branches upwards in an erect position. This gave the plants the appearance of having several main stalks. These branches had little fruiting capacity, as the fruiting branches borne on them were of only two or three internodes in length. On the plants thinned when 14 to 16 inches high, wherever the plants were of normal main stalk structure, practically no bottom crop was borne. The general appearance of such plants was elongated and spindly.

The plants in the 24-inch spacing were of much better structure. Where the main stalk was lost, the large basal limbs developed a good fruiting branch system which bore a heavy crop of fruit. This was especially true of the plants which were thinned when 4 to 6 inches high, and to some extent, of the plants which were thinned when 10 to 12 inches high. Those which were thinned when 14 to 16 inches high developed only a few bolls, or none at all, on the bottom part of the plant. The fruiting branches on all treatments of this spacing were also of better length than were those of the plants in the closer spacings.

Flower counts in the two spacings show that the plants which were thinned when 4 to 6 inches high flowered more heavily during the season up to the end of the dry period in February. From that point, the counts were about the same for the 4 to 6 and the 10 to

12-inch treatments in the 15-inch spacing, but decidedly greater in the 14 to 16 inch treatment in the 24-inch spacing. This latter feature may be explained by the fact that the wider spacing allowed the fruiting branches to develop better than under the crowded conditions of the closer spacings.

15-INCH SPACING.

<i>Height of Plants at Thinning.</i>	<i>Mean Weight in Lbs. per Row.</i>	<i>Number of Plants.</i>	
		<i>Correct.</i>	<i>Actual.</i>
A. 4 to 6 ins. ..	9 ±·328	86	76 ±1·55
B. 10 to 12 „ ..	10·2 ±·357	86	75 ±1·14
C. 14 to 16 „ ..	8·55 ±·397	86	60·8 ±1·08

24-INCH SPACING.

F. 4 to 6 „ ..	12·05 ±·36	54	58 ±·96
G. 10 to 12 „ ..	10·07 ±·44	54	59 ±1·04
H. 14 to 16 „ ..	11·83 ±·24	54	51 ±·57

Difference between A and B treatments: 1·2 lbs. ±·48. $\frac{D^*}{E} = -2·48$.

Difference between F and G treatments: 1·98 lbs. ±·568. $\frac{D}{E} = -3·49$.

Owing to the lack of perfect spacing which occurred in the 15-inch spacing, the results cannot be taken as truly indicative of the value of the spacing. The 4 to 6 and the 10 to 12 inch treatments have nearly the same number of plants, although in each case showing a considerable shortage of the proper number. A comparison of the results of these two treatments gave a slight difference in favour of the earlier thinning, but it was not significant statistically.

The same treatments, in the 24-inch spacing, gave a significant difference in favour of the earlier thinning. This difference amounted to 1·98 lbs. in a row 107·55 feet in length, so it can be taken as of commercial importance. Unfortunately the treatment in the 24-inch spacing, where the plants were thinned when 14 to 16 inches in height, had appreciably fewer plants than had the other two treatments of this spacing. The results cannot be compared, but it is interesting to note that the mean yield for this treatment is higher than for the 10 to 12 inch thinning. This may be explained by the wider spacing having allowed the late thinned plants to develop a larger top crop than did the 10 to 12 inch treatment.

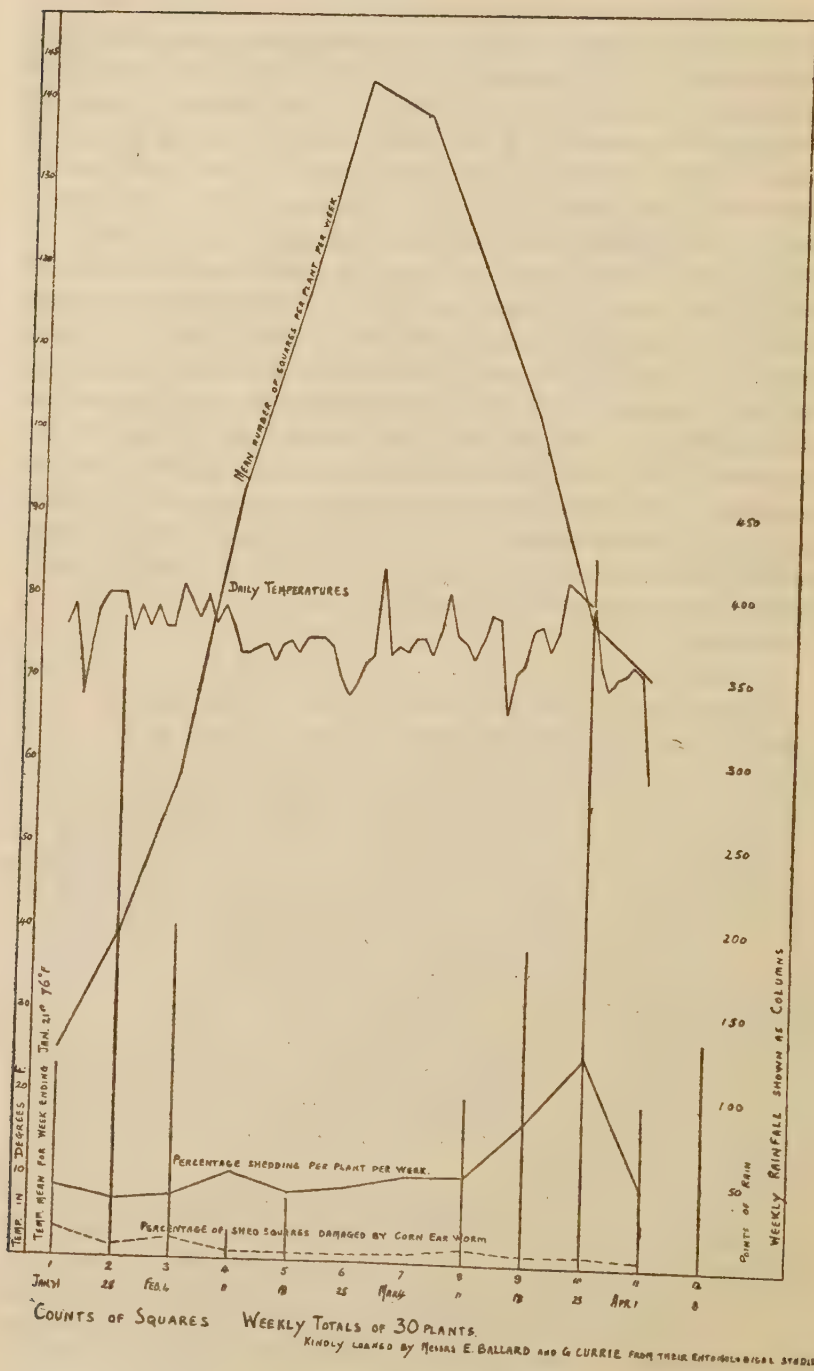
* Difference of means divided by probable error (after Kearney, *Jour. of Agr. Res.*, vol. xxxiii., No. 8).

It would appear, from the results obtained in this experiment, that the grower should endeavour to thin his crop when the plants are from 4 to 6 inches high. This cannot be effected in a large acreage unless extra labour is employed for the operation. Generally speaking, this procedure is advisable, as when the plants are all thinned within a short period of time, the cultivation operations are performed more efficiently. In some instances, however, the grower may not feel inclined to expend much money on hiring labour. It is suggested, in such cases, that under the climatic conditions which usually exist during the latter part of the growing season, the grower would be well advised to employ sufficient labour to enable the entire crop to be thinned by the time that the plants are 12 inches in height. The results obtained from last season's experiment, and observations made in nearly all the districts of the cotton belt, all bear out this recommendation. It is believed that if greater attention is paid to this factor, less damage from rank growth, accompanied by insect attack, will be experienced. This, in conjunction with the larger acreages, will lower the cost of production and help to make cotton-growing a very attractive proposition in most of the cotton districts of the State.

Ridging Experiment.*—The results obtained from the ridging experiment this season are more or less contradictory to those obtained in the similar experiment conducted last season. Two factors may be accountable for this divergency. As was pointed out in the 1925-26 Report for the station, the Manager unfortunately "barred off"* the whole of the experiment in order to check the excessive growth caused by the frequent rains. An experiment was arranged for this season to demonstrate the effect that barring off had on controlling the development of rapidly growing plants. The heavy loss of terminal buds caused the formation of a rank-growing vegetative system. The larger "basal limbs" soon drooped outwards to the ground and in many cases partially split off. It was thought that the use of the disc cultivator would destroy so much of this growth that it would be advisable to omit the experiment. No concrete evidence can be offered, therefore, as to what effect the barring off had on the rows.

The other factors which may have affected the yields are the soil conditions which showed up this season in the border where the experiment was conducted. As has been pointed out, the excessive

*** A method of cultivation whereby the soil is removed from the sides of the row by disc cultivators, in order to allow a drying out of the soil around the surface roots of the plants. This leaves a strip or "bar" of soil along the row of plants, hence the term "barring off."



rainfall caused a sappy, rank-growing plant. Under the dry conditions of the latter part of February, the plants in two sections of the gradually ridged rows shed very heavily owing to "droughty" soil conditions. This loss was never made up, and the final picking figures gave considerably lower yields for each row which was thus affected.

The flower counts on the middle row of each treatment showed that the row which was ridged at the last cultivation had a tendency to produce more flowers each day during the whole of the dry period in February. After the rains set in again, the plants cultivated on the flat seemed to have obtained some advantage, but the total produced for the rest of the season was in favour of the plants which had been ridged at the last cultivation.

It may be that the ridging at the last cultivation, which was done on January 7, provided a heavier mulch around the base of the plants than did the system whereby the soil was worked to the plants at each cultivation; this might explain these plants withstanding the dry-weather conditions to better advantage. Having passed through this period in good growing condition, it would be natural for the plants thus treated to produce heavier yields during the latter stages than did the plants in either the flat cultivated or the gradually ridged treatments.

<i>Treatment.</i>	<i>Mean Weight in Lbs. of 18 Rows.</i>	<i>Mean Number of Plants per Row.</i>	
		<i>Correct.</i>	<i>Actual.</i>
A. Flat cultivated and ridged at last cultivation	9.5 ± .425	64	53.3 ± 3.57
B. Flat cultivation	8.77 ± .319	64	61.2 ± 3.87
C. Gradually ridged at each cultivation	7.44 ± .326	64	59.3 ± 3.81

Difference between A. and B.: .73 lb. ± .53. $\frac{D}{E} = -1.37.$

„ „ A. and C.: 2.06 lbs. ± .53. $\frac{D}{E} = -3.88.$

„ „ B. and C.: 1.33 „ ± .32. $\frac{D}{E} = -4.15.$

As the length of each row was 107.55 feet, or one-ninetieth of an acre in area, it can be seen that some of the differences are of economic importance. Although the difference between the flat cultivated

and the flat plus ridged cultivation is not significant, the tendency to a greater yield and the fact that the final ridging assists in suppressing the weeds, makes the latter treatment the more desirable of the two. The results probably would have been more favourable to the latter treatment but for the abnormal rainfall in March,

Unfortunately an irregularity in the cultivation methods in the experiment of last season prohibited any accurate comparisons from being obtained. The plants in the treatment whereby the soil was worked to the plants at each cultivation gave distinct evidence, during a heat wave in the latter part of January, of having better drought-resistance power than had the plants in either of the other two treatments. It is believed that the soil inequalities markedly affected the results obtained from this treatment for this season, and that in reality there was little difference in the behaviour of the plants in this and the late ridged treatment.

Cotton Breeding.—Further progress has been made in this section of the operations of the station during this past season. A five-acre plot was sown with bulk-selected seed obtained from the 6½ acre breeding block of last season. Unfortunately the plants in this plot suffered considerably in the same manner as those in the rest of the plots on the station. This prevented selection strictly according to type of plant, but in an endeavour to compensate for this omission a most strict adherence to type of fibre, seed, and boll was maintained in making the selections. Ninety pounds of seed cotton were obtained from 240 selected plants. This is a slightly higher mean weight of seed cotton per plant than the selected plants yielded last season. No counts of bolls were made in either season, but the general impression formed of the selected plants of this season was that they bore a slightly higher number of bolls which were of greater weight. Seasonal conditions may have accounted for these increases, as the records of the progeny selections for the two seasons show that the mean weight of 100 seeds in 1925-26 was 14.39 grms. $\pm$.239, and in 1926-27 it was 13.3 grms. $\pm$.194, a difference of 1.09 grms. $\pm$.316, in favour of 1925-26. The mean weight per boll for 1925-26 was 7.35 grms. $\pm$.17, and 1926-27, 7.42 grms. $\pm$.102, a difference of .07 grms. $\pm$.155, in favour of 1926-27, which is not significant. It would appear, therefore, that the better seasonal conditions made heavier lint, which gave a slight tendency for the bolls to weigh more.

The average yield of the 5-acre plot, however, was only 1,224 lbs. of seed-cotton per acre, as compared with 1,254 lbs. for last season. It is believed that the mean acre yield for the plot this season should have been considerably higher. The eastern half of the plot is

marked by a shallow depression in the centre of the borders. In the previous season no effect on the growth of the plant was observed in this area, but in this year's crop the water apparently lay for a sufficient length of time to restrict the growth of the plants.

A comparison of the yields of the $\frac{1}{2}$ -acre borders of this plot is afforded by the following table of results for the two seasons:

K.	1	2	3	4	5	6	7	8	9	10
1925-26	Maize	486	465.5	687	623.5	Maize	543	589.5	698	Maize
1926-27	455.5*	550	566	561.5†	511†	586	649.5	675	713	854
Difference for 1926-27	—	+64	+100.5	-125.5	-112.5	—	+106.5	+85.5	+15	—

In order to obtain a record of the uniformity of the length of staple and the density of fibres on the seed, a boll from each of 100 consecutive plants was picked from the corresponding section of each plant. A seed and fibre from the centre of one lock of each boll was combed and mounted to afford an easy comparison. The photograph (Fig. I) records the results obtained. To afford comparison of the progress that is being made similar material was obtained from a field on a neighbouring farm, which was planted with seed from the bulk stock of commercial planting seed. Fig. II records the degree of uniformity in this stock. It would appear that, taken as a whole, a decided improvement has been effected in the regularity of the length of the fibres on the individual seed, as shown by the smaller amount of "butterfly" effect, and also that a considerable increase in the amount of fibres per seed has been obtained. The latter belief is substantiated by the results obtained from determining the mean of 10 lint indices‡ of bulk lots of seed-cotton from each block, which were $6.29 \pm .29$ and $4.94 \pm .13$, a difference of $1.25 \pm .316$, in favour of the bulk selected stock, which is significant.

A careful roguing of $2\frac{1}{2}$ acres of the 5-acre plot was made during the progress of selecting the bulk lot of plants for further increase. Each plant in the $2\frac{1}{2}$ acres was inspected for seed and lint characters, and

* The yield from Border 1 is not indicative of the true merits of the soil. A slightly reduced stand resulted in a wider spacing between the plants, which caused a very rank growth to be produced.

† The plants in Borders 4 and 5 were the most affected. In a portion of the plots a very restricted growth was produced which undoubtedly lowered the yield.

‡ The weight of lint per 100 seeds.

the crop of any plant failing to conform to the type which is used as the standard of the breeding work in this area was destroyed; 190 plants, or 1.53 per cent. of an estimated 12,375 plants, were removed for various deviations from the standard type. The most prevalent faults were a tendency for the seed to have a greyish fuzz with a slight tendency to green, and semi-nakedness. Only four plants with green seed were found; this is a character occurring in the commercial stocks of seed, and is generally associated with short fibres. In all probability plants carrying this factor are distant hybrids of accidental Durango-American-Egyptian crosses which took place at the sources in the U.S.A. of the original stocks of seed imported into this country.

A further refinement of the seed obtained from the bulk selected plants for next season's breeding plots was made by a careful inspection of the ginned seed, when any deviation of the slightest degree from the standard colour, size, or fuzziness was eliminated. Out of 41 lbs. of seed, some 36 ozs. of seed, or 5.48 per cent., were removed. This process will be repeated each season, and it is hoped will, in conjunction with the method of bulk selecting to a standard type, give a suitable, commercial, uniform stock of seed.

The progeny investigations were continued along the usual lines, but no plant or progeny in the breeding blocks proved to be of outstanding merit. Several selections were made in the most promising progenies for further investigation during the coming season. In addition to these, a considerable number were obtained out of the increase plot of the most uniform progeny of last season. Unfortunately this plot could not be planted until December, owing to the fact that it was newly prepared cultivation and therefore required more than the 214 points of rain which fell at planting time to prepare it for planting. A most remarkable yield at the rate of 1,590 lbs. of seed-cotton per acre was obtained from this plot. This is the first time that late-planted cotton on the station has produced over 220 lbs. of seed-cotton per acre. It is not considered, however, that this result was due entirely to characteristics of the strain.

The heavier soils throughout the district produced excellent crops of late-planted cotton, due, it is thought, to the heavy rainfall causing a "waterlogging" of the soil which restricted the growth of the plant. This check assisted in controlling the development of the vegetative branches, with the result that a splendid fruiting system bearing a heavy crop was developed.

The general results obtained under the conditions warrant the further propagation of the progeny, and, accordingly, an isolated field will be planted with it in the coming season.

The first distribution of selected seed bred on the station was made this season. Two growers adjacent to the area were supplied with sufficient seed to plant 95 acres. Unfortunately 40 acres of this was lost through planting in the dry soil prior to the fall of the first planting rains. Twenty acres of this field were replanted late in the season, but only light yields were obtained. The other grower planted 35 acres following the mid-September rains, and obtained an average yield of 1,254 lbs. of seed-cotton per acre. The seed from this block and the bulk plantings on the station amounted to nearly 29,000 lbs. This will be distributed, in the coming season, to growers in isolated groups in the Callide Valley. Under normal conditions, from such an acreage sufficient seed will be obtained to supply the whole of the Central District's planting requirements.

Similar operations are being conducted in the Upper Burnett district for developing a seed supply for that and the Southern Districts. It can be seen, therefore, that the whole of the cotton belt will be receiving improved seed in another two seasons. The crops, after that, will be supplied with increasingly better seed for each season. This should enable heavier yields to be produced and higher picking tallies to be obtained.

Removal of Cotton Plants after Picking.—The removal of the cotton plants after the picking operations are completed, prior to the preparation of the land for another crop, has constituted something of a problem under the conditions in Queensland. In many of the districts only light frosts, which kill the leaves and tops of the plants and hasten the opening of the crop, may be experienced. Under such conditions the stalks and branches are green and sappy and would not be in a suitable condition for cutting down with the "stalk-cutting" types of machines which are usually used in the cotton fields of the U.S.A. With these machines a series of revolving blades chop the stalks into short lengths which can be ploughed under in the usual ploughing operations.

The growers in Queensland have attacked the problem in several ways, but nearly all the methods have had serious defects. The system which has been most generally used has been to plough out the stalks with the plough set so as just to skim under the ground. The stalks are then raked up by means of the horse-drawn hay-rake or—if in small plots—forked up by hand into piles to dry sufficiently for burning. In some of the districts, where the plants make only a moderate growth, they are ploughed under without any previous treatment. In some instances plots were observed where the plants—which had grown to heights of 5 to 6 feet with stalks of 1 to 1½ inches

in diameter at the butt—had been chopped out by hand with sharp heavy hoes.

None of these methods, however, is satisfactory. Where the plants are ploughed out, the ploughed soil not only covers some of the plants, but also covers up a considerable number of the fallen bolls of the top crop. In many of the districts in Queensland, the Pink Boll Worm (*Platyedra gossypiella*) exists, and in the coastal areas the Peach Grub (*Conogethes punctiferalis*) as well. Both of these insects may be found in the top unopened bolls at the end of the season, and any system of destroying the plants which does not assist in properly eradicating these pests is faulty. Where the plants are ploughed under in the usual ploughing operations not only is there no attempt to destroy the insects, but also the seed bed is prepared badly. The general experiences of the growers throughout the cotton belt indicate that a firm compact seed bed offers the best insurance for the young seedlings to withstand the dry conditions which usually exist during the early period of their development. Under the normal winter conditions little rain falls in most of the districts; where large quantities of cotton stalks are ploughed under, it can be seen that without winter rains the seed bed, with so much refuse mixed in it, must be of an open nature. Therefore, seed beds prepared in such a manner will require very heavy planting rains, or frequent rains during the early growth of the seedlings, to enable them to withstand periods of dry weather of any length. The system of removing the plants by hand-chopping is probably the most efficient method of any as regards the destruction of the top crop of bolls which may contain insect pests. The general experience is that an acre a day is good chopping for one man, so that it can be seen that this is an expensive operation.

The system used on the Research Station has hitherto been to plough out the plants and then rake up by means of a large horse-drawn rake which has long wooden teeth running along the ground in a nearly horizontal position. This rake gathers the plants, but unfortunately leaves a lot of the bolls. In the season of 1925-26 an adaptation of the old slide maize-cutter was used to cut the stalks, and proved to be a decided improvement on the method of ploughing out the whole plant. The cut plants were raked up by the horse-drawn rake again, and much less refuse was left behind.

During the season of 1926-27 the several modifications that have been effected on the slide cutter have developed it into an efficient machine that should be used by all growers with an acreage larger than that which can be cut by hand. Some further improvements



FIG. I.

Showing a seed and combed fibre from one boll each of 100 consecutive plants in the "bulk selected" breeding plots.



FIG. II.

Showing a seed and combed fibre from one boll each of 100 consecutive plants growing in a field of commercial stock of cotton.



FIG. III.

A portion of the increase plot of the "bulk selected" seed. This half-acre plot yielded at the rate of 1,708 lbs. of seed cotton of a full $1\frac{1}{8}$ -inch length of staple.



FIG. IV.—SLIDE CUTTER.

An adaptation of the old-fashioned maize cutter for cutting cotton plants. The box at the rear is a guard over two rolling coulters which serve to steady the machine so that it cuts more efficiently.

NOTE.—After the photograph was taken, it was found that a 6-ft. blade instead of three sections of saws gave better results. Width of saws should clear frame by 3 inches.



FIG. V.—REAR VIEW OF SLIDE CUTTER.

Showing the method of attaching the rolling coulters. These are of decided assistance in steadying the machine, which has a tendency to swing from one row to the other owing to the irregularity of the spacing of the plants.

Dimensions of machine are as follows: Length, 10 ft. Width at widest point, 7 ft. Width of back carriage, 3 ft. Length of arms, 8 ft. 6 ins. Framework, 4 x 3 ins. hardwood.

are contemplated to be tested in the coming season in order to lessen the draft, but it is believed that a description of the machine in this report is justifiable. The photographs which are included (Figs. IV and V) are of the machine used at the station this past season.

It was found that with two horses hooked in tandem, in an 8-hour day, 8 acres of cotton could be cut if planted in rows 65 feet long and spaced $4\frac{1}{2}$ feet apart, with the plants spaced 20 to 24 inches apart. The plants averaged around 5 feet in height, and from 1 to $1\frac{1}{2}$ inches in diameter at the section where cut. Where the stalks were taller and of greater diameter it was necessary to use three horses in tandem, but this cotton was ranker than is usually encountered.

A departure from the use of the large horse-rake in piling up the bushes was also made. An experiment in using a three section lever spike-toothed harrow, drawn by a Fordson tractor, proved to be quicker and more efficient, and accordingly the whole of the crop was cleaned up in this way. It was found that the harrow raked up the plants in such a manner that the field was partially swept, which prevented most of the fallen bolls from being left behind. The harrow automatically dumped itself by riding over the accumulated pile of plants when too many were gathered under it to allow the back teeth to remain on the ground. This left the plants in rows and bunches over the field, where they could be forked up easily and burned when dry. An ordinary horse hay-rake was used to clean up after the burning operation, which left the field in a much cleaner condition than had been possible with any other operation except hand-chopping. Eleven acres a day could be covered in this manner, and about another day was required to clean up with the horse rake after the first burning off of the piles of dry plants. The Manager, in reporting on the use of the harrows, suggests that horses could be used instead of the tractor. He also suggests that harrows with long spikes may be preferable, and that the back of the harrow should not be too heavily weighed down or it will not ride over the piles of plants.

It is suggested that every grower should equip himself with a slide cutter. It is a comparatively cheap machine, and will enable the cotton crops to be removed quickly after the harvesting is completed. This allows the seed bed to be prepared in time for advantage to be taken of the first planting rains, and this, in most seasons, renders possible the production of a profitable crop of cotton.

INSECT PROBLEMS.*

This season has been marked by the occurrence of a series of insect visitations. Cut Worm† attack gave promise of being particularly serious soon after the planting period. The Corn Ear Worm‡ appeared in startling numbers in mid-season and continued to be present in varying numbers throughout the rest of the season. The Pink Boll Worm,§ while present, did not appear to be as prevalent as in the previous season. The sucking insects, Harlequin Bug|| and the Large¶ and Small Stainers,** occurred in large numbers, and a new insect named the False Stainer†† also appeared, which caused considerable loss of squares.

It cannot be said that any definite remedies were found for the prevention or the checking of the attack of any of these insects. A very valuable amount of information, however, was collected on their behaviour, which will contribute to a better understanding of the problems connected with each insect.

Cut Worms.—Cotton was planted from September 28 to October 8. On October 13, cut worm larvæ in the second instar were discovered in great numbers on the east side of blocks I and J. By October 15 serious damage had been done to the cotton seedlings, the cotyledons being mostly destroyed and the stems badly pitted above and below the ground level. The attack appeared to be in the form of an invasion from the weedy headlands along a "party" fence. A mash of calcium arsenate and bran was applied, but the larvæ were too small to eat the mash when it dried out. The peak of the attack occurred around October 20, and gradually ceased after that, but not until five acres of cotton in I block were so badly damaged as to make them unfit for experimental work. The attack ceased all over the valley about the same time, so it is questionable if any check was obtained through the distribution of the poisoned mash. The experiences of growers in other districts demonstrated that the Paris green mash completely stopped the attack of the older Cut Worms, and experiments later in the season at the Research Station confirmed this.

* Full descriptions of the insects mentioned as occurring at the station this season are given in the Bulletin, *Cotton Growing in Queensland*, issued by the Department of Agriculture and Stock, November, 1927.

† *Euxoa radians*, Guen.

‡ *Heliothis obsoleta*, Fab.

§ *Platyedra gossypiella*, Saunders.

|| *Tectocoris lineola*, F.

¶ *Dysdercus sidae*, Montr.

** *Oxycaenus luctuosus*, Montr.

†† *Aulacosternum nigrorubrum*, Dall.

Corn Ear Worm.—The larvæ of this insect appeared in countless numbers during January, but were attracted more to the pig weed in the ploughed wheat stubbles than to the cotton plots. Mid-February saw another brood emerge, but no real damage was done to the cotton until early in March. Severe attacks on the late planted cotton were experienced then, and these continued until the 12th of the month. Heavy rains occurred at this period, after which the attack lessened. The early planted plots escaped any serious damage from the attacks of this insect. This is in accordance with similar results obtained in previous seasons. It is of particular interest this season, however, because, while the plots were planted early, the main growth of the plant was delayed until the occurrence of the December rains; it would appear, therefore, that early planting undoubtedly offers a high degree of immunity from the attack of the Corn Ear Worm.

Pink Boll Worm.—At the end of the cotton season, in 1925-26, a considerable population of the Pink Boll Worm was found in the older cultivation plots of the station. After the old plants had been cut and burned these plots were raked by hand labour with large garden rakes. This insured a clean-up of all bolls which had fallen off in the processes of removing the plants. Careful examination of the crops on these plots at the end of this season showed that only a very small percentage of the bolls were infected. The plots accordingly were not hand-raked again, especially as a new method of raking the plants into heaps for burning had been devised by which a better clean-up of the fallen bolls is obtained. It is believed that with the use of this method a sufficient clean-up will be made each season to reduce the population of the Pink Boll Worm on the station to a negligible amount.

Sucking Bugs.—The Harlequin Bug appeared on the station this season, after a nearly complete absence during the last season. From observations made it would appear possible that hand-picking of the egg clusters may offer an efficient method of controlling this insect. Experiments will, therefore, be conducted during next season to demonstrate the efficiency of this method of control, and also the cost thereof.

The *Large* and *Small Stainers* occurred in large numbers during the maturing period of the crop. Investigations in controlling their attack by different forms of traps or lures did not offer any solution of this problem. Valuable information regarding the method of migration and the feeding habits of the Large Stainer was obtained, as a result of which a comprehensive survey of a large district, in

another portion of the State, will be conducted during the winter months and through the season of 1927-28. It is hoped to obtain further information on the migration habits of this insect which may indicate possible means of control through eradication of natural food plants.

The False Stainer.—This insect appeared in large numbers on the station for the first time. Its close resemblance to the Large Stainer has given it the name False Stainer. Considerable loss resulted from the attacks of this insect on the young squares. No method of control was found.

SUMMARY BY MR. E. BALLARD, COTTON ENTOMOLOGIST ATTACHED BY THE CORPORATION TO THE GOVERNMENT OF AUSTRALIA, OF HIS WORK IN QUEENSLAND, 1924-1927

GENERAL.

ON my first appointment as Cotton Entomologist to the Commonwealth Government the cotton boom was in full swing, and it was confidently expected that New South Wales, Victoria, and West Australia would grow cotton as well as Queensland. One of my duties would have been to train in Cotton Entomology junior men from each of these States, so that after the expiry of my term of service they would be in a position to continue the work which I had initiated.

It was, however, very soon evident that Queensland alone would produce cotton in any quantity, and my headquarters were consequently placed in Brisbane. This report refers therefore only to insect pests of cotton in Queensland, as the other States soon abandoned any idea of cotton growing and had no need for my services.

The Queensland Government provided me with office accommodation and the use of the clerical staff attached to the Cotton Section.

During my time in Queensland I always worked in close association with the Section, both while it was under Colonel G. Evans and after his departure, when his place was taken by Mr. W. G. Wells.

An assistant was seconded from the Entomological Section for training under me, and arrangements were made for him to be stationed at Biloela at the Cotton Research Station which was being founded.

This assistant left the Queensland service in July, 1925, after being with me for about fifteen months, and took up a position as Lecturer in Zoology at Adelaide University. From that time, until the middle of November, 1926, I was single-handed. This proved a serious handicap, since one could not do the necessary field work and laboratory work at the same time, as much of the latter demanded continuous daily observations. A plot of cotton grown at Government House in Brisbane was placed at my disposal by the Cotton Section, and was of great use as a field laboratory. With the

appointment by the Home and Territories Department of Miss G. Evans as personal assistant in November, 1926, I was enabled to leave Brisbane and spend some time at Biloela, and the appointment of Mr. G. A. Currie by the Queensland Government for entomological work with the Cotton Section made it possible to have him posted at Biloela to watch the progress of work there, and I was thus free to oversee the research carried on both at the laboratory in Brisbane and in the field at Biloela. Mr. Currie will continue on cotton research after my departure.

During my first eighteen months in Queensland I visited as many typical cotton-growing areas as possible to familiarize myself with the conditions, and to arrive at some idea as to the outstanding entomological problems which demanded the earliest attention.

The conditions of living and working in the early days of the Research Station were primitive. Such a state of affairs is, of course, inseparable from the pioneering stage, but has its effect on reducing the output of research work of an intensive or detailed nature. On the other hand, it was sufficient to enable one to get a very thorough field knowledge of the behaviour of various pests, without which no laboratory work is of any value. Conditions at Biloela are now very much improved, and the Station affords in many ways an ideal place for entomological work, as plots of crops can be set aside for the entomologist, and he can use them for any experimental work he wishes.

ENTOMOLOGICAL PROBLEMS.

The first problem with which I had to deal was that of the Pink Bollworm.

The discovery of this pest was announced just prior to my arrival in Brisbane. Steps were taken at once to ensure disinfection of the seed and to endeavour to restrict the area of infestation as far as possible. The rest lay in the hands of the farmers, who could only hope to keep the pest in check by ensuring a season between one crop and another when no cotton was in the ground, and by thorough cleaning of their fields from all trash and débris after cutting out the crop. This was a matter for education and experience. Little could be done in the direction of urging the enforcement of the close season owing to the bitter feeling aroused by the ratoon controversy. Standover and ratoon crops were grown in some districts with dire results, particularly at Mount Larcom, a most promising cotton area. This was a centre of pro-ratoonists, and suffered heavily from Pink Bollworm, and the area under cotton has sunk from 3,000 to under

100 acres in the present year. There are now very few farmers who would grow ratoon cotton, as everywhere in the Pink Bollworm areas the experience has been the same.

The Pink Bollworm is established in all cotton-growing areas north of Maryborough, but with the exception of the places where ratooning was the practice, it has not done any serious damage over the inland cotton areas, although it is much more prevalent on the coast. Generally speaking, the situation is in hand. Provided that due precautions are taken in seed disinfection, and quarantine inspection of imported seed and seed cotton, great loss from Pink Bollworm need not be anticipated.

The Callide Valley, where the Research Station is situated, is unfortunately infected, but now that a really thorough cleaning of the cotton fields on the Station takes place there has been no increase over the first attack, but a very marked diminution instead, and the farmers of the Settlement are alive to the necessity of an early clean-up of their fields. The incoming cotton at the ginneries is inspected periodically as a means of checking the distribution of the pest and ascertaining new localities, if any. This is the most reliable method of obtaining a knowledge of the distribution which we possess at present. It is combined with reports from the Field Staff of the Cotton Section, all of whom have been given sufficient entomological instruction to enable them to recognize the chief pests which they are likely to meet with in the course of their rounds.

From time to time, as opportunity afforded, field notes were made on the Pink Bollworm, and Mr. Holdaway has published a description of the caterpillar, which appeared in the *Bulletin of Entomological Research*. Apart from this, no intensive work has been done on it, as there were three other pests which, being spread throughout the entire cotton belt, did a greater amount of serious damage and thus demanded immediate attention.

These three pests were the Corn-Ear Worm (*Heliothis obsoleta*, F.) and two sucking bugs, *Tectocoris lineola*, F., and *Dysdercus sidae*, Montr.

The former damaged bolls and squares by eating them, and the latter two pierced green bolls and seeds, and thereby made an entrance for the spores of fungi, causing staining and destruction of the lint, and also damage to the seed and consequent lessening of germination.

Heliothis frequently prevented the production of any crop at all, while the two bugs damaged any crop that was set and lowered its grade and consequently its price.

Field observations soon gave every indication that *Tectocoris*

lineola was an insect to be reckoned with. Moreover, very few farmers realized how much damage it was doing, and it became necessary to demonstrate its powers of destruction, and to provide evidence to convince cotton growers that it must be controlled. Accordingly, this insect was selected for the first life-history studies in the 1924-25 season. At the same time field work was being carried out on *Heliothis obsoleta*, and another caterpillar, *Conogethes punctiferalis*, which also damaged cotton bolls.

It was realized that all methods of control would have to be devised on the most economical basis, as few, if any, of the farmers had the capital to spend on insecticides or machinery, and consequently all efforts were made to find some purely cultural operation which could be included in farm routine and which would give relief from the more serious pests. Control of minor pests was not economically advisable. At the end of the 1924-25 season the life-history of *Tectocoris lineola* was published, together with evidence of the infection of green bolls with fungi through wounds made by it while feeding. This paper appeared in the *Bulletin of Entomological Research*, vol. xvi., part 4, 1926. During this season I was able also to demonstrate that a fungus infection of cotton seed following on bug punctures was one of the chief causes of poor germination, a problem which had exercised the minds of the Cotton Section. Two papers were prepared and published in the *Queensland Agricultural Journal* for the information of farmers, embodying these results and describing typical fungus damage to bolls, lint, and seed.

Following on this discovery of the cause of low germination, the Cotton Section raised the seed rate for planting to 20 lbs. to the acre. This is sufficient to ensure a good stand, even in the presence of a 40 per cent. infection.

In August, 1925, I accompanied Colonel Evans on a tour of proposed cotton-growing areas in Papua and New Guinea, and returned at the end of October. Two pamphlets were prepared and published for the use of cotton growers in these territories, one on Stainers (*Dysdercus cingulatus*) and one on the Pink Bollworm (*Platyedra gossypiella*, Saunders).

The Pink Bollworm was reported as a pest of cotton in New Guinea and Papua for the first time. A report of this tour has already been submitted, and the scientific results recently appeared in the *Bulletin of Entomological Research*, vol. xvii., part 3.

On my return to Queensland, arrangements were made at Biloela for testing the efficacy of maize as a trap crop for *Heliothis*. That season presented a very favourable opportunity for this experiment,

because new country had been brought under cultivation, and as this had only been done shortly before planting time, the bulk of the crop was late planted—that is to say, in November instead of September. The previous season was one favourable for early planting, and, in consequence, only a very slight *Heliothis* attack was experienced, so that no really good opportunity of studying *Heliothis* had been afforded, either from the point of view of insecticidal or any other form of control.

The trap crop was a complete success, 1,200 to 1,500 lbs. seed cotton to the acre being harvested, while neighbouring crops planted at the same time were nearly a total loss. This season came to an abrupt end, and *Heliothis* material was difficult to obtain, but in spite of this, as the result of a study of temperature responses and the general life-cycle of *Heliothis*, the full significance of early planting was realized.

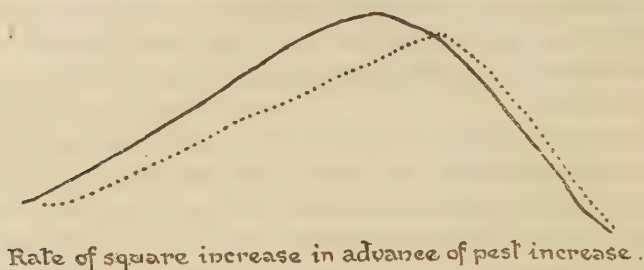
This point has been dealt with in previous reports, but it would not be out of place briefly to recapitulate the factors involved.

In the late autumn and early spring, the mean air and soil temperatures are such that *Heliothis* is only able to increase slowly, the velocity of development increasing as the summer approaches, until the maximum population is reached in January and February, declining after that time due to the action of parasites and the falling temperature. At the temperatures prevailing at Biloela in September to December, *Heliothis* can only produce one and a half generations, while in the months of December to March three generations can be gone through. The first moths emerging from hibernation in the spring can only be a small fraction of those which went into hibernation, so that with a small number of parents to begin with, and a slow rate of growth, the population produced by the first generation is still comparatively low. If cotton has been planted in September, it is setting squares while there are only relatively few caterpillars to destroy them, so that as the population approaches its maximum there are ample squares both to feed the caterpillars and set a profitable crop. A cotton plant always sets far more squares than it ever matures, whether pests are present or not, and if some squares are eaten, they only take the place of those which would have been shed in any case.

With the late planted crop, squares are beginning to be set as the *Heliothis* population approaches its maximum, and the squares are removed as fast as they are set. If, now, the summer rains come as is usual, the plant, having no fruit to check its vegetative growth, produces only stalks and leaves, and gives up trying to set fruit,

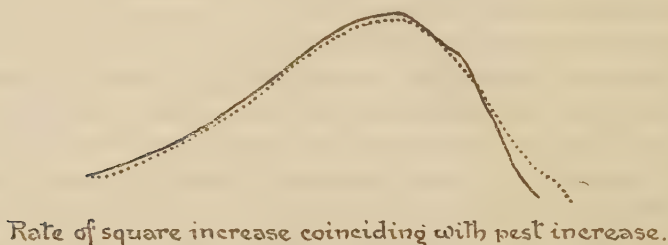
with loss of crop as a consequence. After these conclusions had been drawn, case after case was examined to check their accuracy, and in no instance were they found to fail.

Diagrammatically, the matter may be represented thus:



1. EARLY PLANTING.

—— Rate of increase of square setting
 Rate of increase of Heliothis.



2. LATE PLANTING.

—— Rate of increase of square setting.
 Rate of increase of Heliothis.

This discovery was of importance from two points of view. Firstly, it strengthened the case of the Cotton Section in its advocacy of early planting, and, secondly, it provided a sure method of Heliothis control which would be economical, being a part of sound farming practice, and in even a dry season within the reach of nearly all farmers in the cotton belt.

There had been a certain section of farmers, and their self-appointed advisers, who supported the idea of late planting, as they stated that the spring rains were not sufficient for sowing. The Cotton Section, on the other hand, maintained that it was a question of good farming adapted to the needs of the country as opposed to bad farming. Their contention has been amply supported at Biloela, where, in the season now ending, sufficient moisture had

been conserved to ensure the establishment of seedlings, and in the presence of a very severe drought the plants actually grew and established a root system, and large crops are expected (ranging from 1,700 to 1,750 lbs. per acre).

The whole question turns on "dry farming" practice, winter fallows to take advantage of winter rains and conservation of moisture. In the present season, early planting failed in some places where, owing to the severe drought, no growth was made by the plants, and they did not begin to develop until December. In this case they were functioning as late planted crops, although actually planted early. This, however, is exceptional, and does not affect the general principle.

Arrangements were made early in the season for a block of November planted cotton to be placed at my disposal on the farm at Bileola for careful tests of the efficacy of calcium arsenate dusting to be made, so as to be able to arrive at the probable cost of the operation, and the manner in which it could be most economically used. Should the tests prove a success, it was hoped that the co-operative possession of dusting machines could be established in various centres, so that where the weather made early planting impracticable (as actually happens every season in one district or another), an alternative control to the trap crop would be provided.

For this purpose, a three-row cotton duster of the latest pattern was purchased from the United States, together with an ample supply of calcium arsenate dust.

It might be said, in passing, that dusting was relied on rather than spraying, owing to the ever-present water shortage throughout most of the cotton belt.

The bulk of the cotton on the farm had been early planted, and no trap crops were used, as we were convinced that this early planting alone would ensure protection from *Heliothis*. In the event, this faith was justified. One acre of early planted cotton was provided in my own block as a check against the November plots.

Such were the arrangements made. From the beginning, however, everything went wrong. First the prolonged drought made all planting, after the first week in October, impossible until just before Christmas; secondly, the early planted crop in my block was partially submerged in a flood in December, and was abandoned.

Another factor which had not been anticipated was a large area of fallow covered with Pigweed (*Portulaca oleracea*), a weed which has a strong attraction for *Heliothis*. The population in this was estimated at 1,000,000 to the acre. This weed was eventually ploughed in, but moths from the vast accumulation of pupæ flew to

the three acres of December and January planted cotton, and heavy oviposition took place. This invasion was not at all typical, and being unexpected, upset the revised dusting programme—which had been drawn up on a basis of two applications of 7 to 8 lbs. to the acre—which was to be tried on this late planted cotton. This proved quite insufficient in the face of so heavy an attack, although on one strip, dusted at 15 to 20 lbs. to the acre, some success was obtained. Another point was that late December or January planted cotton has no chance, save in exceptional circumstances, of setting a profitable crop. The first dusting was done in January on October planted cotton, but on this the infestation was so light that no conclusive results could be obtained.

What information was gathered from the dusting we were able to do showed that 7 to 8 lbs. per acre was insufficient, and that 10 to 15 lbs. at each application would be necessary. Experience was also gained in the use of the three-row dusting machine, and a basis for further experimentation for next season was arrived at. Arrangements have been made for the continuation of this work next season.

Additions have been made to our knowledge of the bionomics of *Heliothis*, including a list of its natural enemies, many of which are recorded for the first time, and an important point—the period of hibernation and spring emergence—has been more or less fixed. No exact date can be given, as much depends on the severity of the winter, and the lateness or otherwise of the spring. In connection with this, a continuous record of soil temperatures is being kept, which will be correlated with observed emergence and disappearance of the insect. At the same time, specimens are being kept in the laboratory in Brisbane for further study of their responses to temperature in the multiple temperature incubator. A scheme for further study of this most important insect is being drawn up, and will be left with the State Entomologist.

Heliothis is an insect of world-wide distribution, and much work has been done on it in other countries, but although this gives one a general guide for its study in Australia, everything has to be gone over again with reference to local conditions, and this applies not only to bionomical work but also to control experiments. A method which is a success in the United States, for example, is not necessarily so in Queensland, and *vice versa*.

So long as a fairly favourable planting season is experienced, the problem of *Heliothis* control for Queensland is solved. What has to be done now is to perfect methods of dealing with it in abnormal and unfavourable seasons.

Having no control over the climate, one's work is often upset by unexpected dry or wet periods, and although valuable information may be gathered during such times, a previously drawn up programme often has to be abandoned. This was exemplified in the last two seasons, during the investigations into the life-history of *Dysdercus sideæ*, Montr., the Cotton Stainer. The connection of this insect with the incidence of internal boll rots was established in 1925, during the course of the work with *Tectocoris lineola*. An intensive study of its behaviour was initiated in 1926, and is still in progress.

Experiments begun at the end of the 1924-25 season gave some indication that crushed seed kernels might prove to be sufficiently attractive to be used as a lure, and so enable us to trap *Dysdercus* as it came to the fields. These experiments were repeated in 1926 and 1927, but did not support the first favourable impressions. It was soon realized that some other means must be sought for prevention of damage, and for this purpose a study of all its reactions in every possible direction was necessary, so that some point in its life-history might be found at which it could be attacked. Here, again, the investigations were complicated by the climatic factors.

In 1926, instead of arriving in the cotton in December or January, as previous experience had led one to expect, the first migrants did not appear until March. About this time a drought set in, and the cotton at Gatton College, which had been selected for field study, had to be abandoned. As I was single-handed at this time, and had work in the laboratory which could not be left, the only spot available for field observations was the experimental plot in the gardens of Government House in Brisbane. This provided for a short time sufficient material for study, until the crop collapsed from the effects of the dry weather, and the insects departed from it. Work then necessarily had to be carried on in the laboratory—this was continued all through the winter, and extensions of it are still in progress. During the present season *Dysdercus* was again very late in beginning its migration, so that the period for experimenting with traps in the field was very short, there being only time for one generation to be produced by the first arrivals in the fields before the early frosts caused the cessation of activity on the part of the insect.

Several varieties of traps were tried based on the results of the study of food preferences, desire for moisture, and so on, arrived at last year. None of these, however, gave promise of becoming an economical form of control, and all insecticidal methods, both from the conditions of the crops and the expense which would be involved, were out of the question.

One habit was discovered which may lead to a successful control, and this was the massing of the last stage before becoming adult in suitable shelters. The normal cotton crop does not provide such shelter, which is readily obtainable in the bush. Strips of ironbark bark or boxes would always be thronged by insects in this stage of development. It was observed in the bush during the summer, and took place in the fields when the type of shelter desired was erected. What made it difficult to proceed with this experiment was the onset of winter, which, by introducing the factor of cold, made it uncertain whether during the summer we should be able to induce such large numbers to seek shelter at this period of their life-history.

In the laboratory the study of the life-history has been concluded in such details as the methods and times of oviposition, length of life in summer and winter, temperature responses, and moisture requirements. The effects of different types of food are still under investigation, although much has been learned. These are of more than academic interest, seeing that they may serve as a basis for forecasting prevalence in any particular season, as undoubtedly much depends on the wild food plants which are available, and their rate of increase on such plants. Some of this work, if carried through, may have an even wider application. Similarly, the study of the responses to temperature and humidity will be of value, not only in connection with *Dysdercus*, but with the response of insects in general to climatic conditions.

The study of the reaction to varying humidity was much more difficult, and could not be carried out without considerable expenditure on apparatus, which did not seem to me in the circumstances to be justified. It was possible to ascertain, however, that aridity was detrimental and humidity essential to them. The optimum conditions of temperature and humidity could only be gauged approximately, but a high humidity with a moderately high mean temperature (80° to 85° F.) seemed to provide the best conditions for development.

Allusion has been made to migrants in the course of the section of this report dealing with *Dysdercus*. This calls for some further explanation.

During the spring and summer months we have found that *Dysdercus* is subject to waves of migration. This does not apply to all individuals, but it is by these migrants that the cotton fields become infected. In areas where bottle trees or other species of the genus *Brachychiton* are found, such places seem to form the foci from which migrants spread. During the summer these migrations

appear to follow the line of the water-courses. They have, so far as we have been able to ascertain, no relation to cotton or other food, but are the result of some unknown impulse which sets the insects on the move, something akin, perhaps, to migrations of locusts.

We were able to observe such a migration in some detail this season at Biloela, and by means of marked insects to follow up its course. The chief gap in our knowledge now concerns the winter feeding habits, and whether there is a return migration to the bottle trees or not after cotton is pulled out. Personally I am of the opinion that this does not take place, but absolute proof is lacking.

A paper has been prepared which it is proposed to publish in the *Bulletin of Entomological Research*, embodying the results of the two seasons' work on *Dysdercus*.

Further experiments with traps will have to be made next season. In an early planted crop *Dysdercus* and *Tectocoris* do far more damage than other insects. Very few farmers realize how much loss is occasioned through staining, but their numbers are increasing. *Tectocoris*, from its lethargic habits, can easily be controlled by hand-picking, but with *Dysdercus* it is otherwise, and the ordinary cotton seed traps, which can be used in tropical countries with cheap and abundant labour, are useless in Queensland. For this reason some other form of control is necessary, and it is essential to have this perfected by the time the growers have realized the necessity for it.

Working through the Field Staff of the Cotton Section, some good demonstrations were made of the use of poisoned baits for controlling cutworms. Early planted cotton has this disadvantage, in that the seedlings appear at about the time when there is little natural food for the cutworms, so that they invade the cotton fields. Control is a simple matter, and success mainly depends on the farmer noticing the beginning of the attack in time and spreading the bait in the vicinity of the invaders.

For two seasons warning of cutworm attack, and the methods to adopt to check it, had been published in all the newspapers circulating in the cotton areas. The farmers, after the manner of farmers the world over, took no notice of these articles, and considerable loss from cutworms occurred. In the present season demonstrations were given on several farms, with such good results that one can confidently hope that few farmers will be taken unawares in the coming year. The written word is practically useless as a means of instructing farmers in methods of pest control, and demonstration alone carries conviction. Some valuable observations on cutworms

were made at Biloela early in the present season, which will form a basis for further work, which can be taken up as time permits.

The larva of the Yellow Peach Moth (*Conogethes punctiferalis*) is another insect which damages cotton bolls, chiefly the last-formed bolls of early planted cotton. Late planted cotton also often suffers severely. This insect is interesting in many ways. In the first place, although of world-wide distribution, it only attacks cotton in Queensland and New South Wales. Its other food plants are very numerous. Amongst these is included maize.

There appears to be a definite connection between the ripening of late maize crops and the infestation of cotton by Peach Moth. With early planted cotton which has maize in the vicinity (as is usually the case) when Peach Moth eventually comes to it after the ripening of the maize, the bolls are in too advanced a stage for any but negligible damage to be done. With late planted cotton much of the crop is still green, and serious loss occurs. In the absence of maize early planted cotton is often badly damaged, as happened in the Boyne Valley this season (1926-27).

This is the situation in the present cotton areas. In the more northern part of the State where cotton has been tried in one or two places, Peach Moth seemed to make its attack earlier in the year and to do more damage. As, however, these patches of cotton were well outside the main cotton belt, no observations have been made in them, as it was essential to concentrate on the areas where most cotton was grown or was likely to be grown.

The insects dealt with in the foregoing pages constitute the chief pests of cotton in Queensland, and all future research should be concentrated on them until the gaps in our knowledge concerning them are filled.

There are numerous other insects which live on cotton, and all take their toll in one way or another, but the aggregate loss is probably not very great. One or two of these may become major pests at a future date, but at present no work is called for in connection with them if it would interfere with the study of the other insects which are "known depredators."

FUTURE RESEARCH.

When I first took up my duties in Queensland, I found that, although the principal cotton pests had been recorded, little or nothing was known of their life-histories, relative importance, or general habits. No research of a fundamental nature had been done. There

was therefore a considerable amount of spade work to be done first, before one knew the chief direction in which one's energies should be applied. For the most important insects this work has now been done, and for one or two of them carried further.

Realizing that three and a half years did not give one sufficient time thoroughly to investigate even one pest, I decided to try to establish a basis upon which the future research work should be founded.

In my opinion applied entomology in the past has been much handicapped by the tendency to treat symptoms instead of tackling primary causes. The point was often overlooked that the study of any insect must be carried on with reference to its environment. Not only the climatic factors constitute this environment, but also the plants upon which the insect lives, the nature of the soil in which the plants grow, and also their reactions to meteorological conditions.

Modern applied entomology is carried along on these lines, and although there is a strong body of public opinion which thinks that the entomologist must have a remedy ready for every pest which is brought to his notice, and that he is no use unless he can provide one, this only arises from an incomplete understanding of the nature of the problem.

Many entomological problems can only be solved by team work, a chemist, an entomologist, and a botanist, for example, all working on the same investigation. This method of work takes time, but when results are achieved they are likely to be far more lasting than any arising from the study of an insect without reference to its environment or the stimuli which control its behaviour.

It was not possible to collect a sufficient amount of material on *Heliothis obsoleta* to warrant publication. On the other hand, notes have been made throughout the seasons of food plants, parasites, and soil temperatures, which will, when correlated with other work, help to give a true picture of all the factors which fashion its life.

I consider the study of climatic responses most important, and second only to this the effects of feeding and food preferences. An ideal to which one should work is that of having so complete a knowledge of the major pests that the forecasting of their appearance or disappearance should be possible.

A study of the plants attacked will often throw light on the causes of the attack, and quite possibly may result in its defeat by treating the plant alone and disregarding the insect.

One example of this is the control of *Heliothis* simply by planting by a certain date, and another, also taken from Queensland, is given

by the infestation of cotton plants in certain districts by a small sucking insect commonly called a leaf hopper (*Empoasca* spp.) This insect is so prevalent on cotton growing in volcanic red scrub soils that a crop is seldom harvested. The leaves cockle and turn red, and the plants are stunted. It was found that such soils were always deficient in potash and phosphoric acid. Leaf hoppers are always to be found on any cotton plant in Queensland, but it is mainly on unhealthy plants that they become a pest. Potash and phosphoric acid are both of primary importance to cotton, and with insufficient amounts available in the soil the plants are ill-nourished, and, being unhealthy, seem not only unable to resist hopper attack, but hoppers breed on them in enormous numbers. A similar state of affairs existed in Rabaul, where the cotton was very heavily infested with leaf hoppers. Here, not food deficiencies, but what was probably lack of drainage, put the plants into an unhealthy condition and rendered them subject to hopper attack. Cotton in Queensland also suffers from scale insects and Mealy bugs when, and only when, its vitality is low.

Future cotton pest research work should be carried on on these lines, and the recording of meteorological and other data which has been begun will not, I trust, be allowed to lapse.

In conclusion, I wish to record my appreciation of the cordial relations which have always existed, not only with members of the Cotton Section, but also with such other sections of the Department of Agriculture with whom I have come in contact. Naturally, I have had most to do with the Entomological Section, but whenever help was required from others it was always forthcoming.

SOUTH AFRICA

REPORT ON THE WORK OF THE COTTON- BREEDING STATION, BARBERTON, TRANSVAAL, FOR THE SEASON 1926-1927

BY

F. R. PARNELL.

INTRODUCTION.

Station.—The layout of the station was finished during the year, the rectangular cultivated block being divided into twenty-four fields. The latter are all of the same shape and size, $2\frac{1}{2}$ acres, except four fields which were cut down to about 2 acres each to give room for buildings.

It has been decided to alternate cotton with fallow over this area, thus giving about 29 acres of cotton each year. Some rotation is essential as, apart from the requirements of good farming, it is most necessary to avoid volunteer plants, either self-sown or ratoons. The hand-planting of single seeds in selection work demands very good conditions if a satisfactory stand is to be obtained; moreover, the planting should occupy as short a time as possible, and rapid work, again, demands good conditions. The fallow was adopted instead of a rotation crop, therefore, as it allows of the land being got into good order before the early rains, and no time need be lost when good rains have fallen.

It was evident that the work of the station would be cramped if confined to the area originally taken up. An additional area, nominally 70 acres, of land already in cultivation, was, therefore, taken on a temporary lease from the Municipality. This provided land for the provisional small-scale multiplication of a number of strains of cotton that were promising, and that might be wanted in bulk after further trial. In addition, it gave room for plots of likely rotation crops, cattle fodder, etc.

The facilities of the station were improved by the addition of a foreman's house, a well and pump, and a few articles of furniture in the work shed.

Proposals have now been made for an expansion of the work, an enlarged station on a more permanent basis, and the provision of proper laboratory accommodation.

Season.—The season was the driest on record in this district, the total rainfall for the eight months, September to April, being only

16.7 inches. A reference to the diagram and figures at the end of this report will show that the whole planting and main growing period was extremely dry, the fall being only 7 inches from October 1 to February 23.

The earliest rain on which planting could be done fell about the middle of November, but even then the soil was not properly wetted through. Practically all the single-plant lots were rushed in on this rain, however, and a good stand was obtained. Planting had to be stopped after a few days, as it became too dry, and from then on a number of small plantings were made as opportunities offered. Most of these later plantings gave practically no crop, as conditions were all against them, and such showers as fell were dried out again in a few days.

The earliest plantings, mid-November, managed to keep alive, but made no real growth until towards the end of February, when the first thorough soaking, $4\frac{1}{2}$ inches of rain in four days, was received. Up till this time they had varied mostly between bad and worse, and their survival showed the remarkable hardiness of the cotton plant. Growth started very vigorously after this rain, but at a time when the greater part of the vegetative growth should already have been made. Flowering and boll-formation were very late, but, even so, a fair crop would have been obtained from most lots had it not been for a cutting frost in the middle of May. This frost was exceptionally early for these parts, and wrought havoc in the district, as crops of all sorts were very late and far from maturity. On the station all the late-planted crops were wiped out, and of the first plantings only the most early maturing types escaped serious injury.

SELECTIONS.

This work was continued on the same lines as those indicated in previous reports. The material comprised only re-selections, second- or third-year lots, since no original selections had been made in the previous season. A total of 328 single-plant lots were put in, ranging from four to twelve rows of 41 plants each. This short progeny row was adopted to make it more easy to look over a lot, and form a mental picture of it as a whole, when making field notes.

In addition to the above lots bulk seed of a number of promising strains was planted on multiplication plots of from $\frac{1}{2}$ to 1 acre each, in order to provide seed for trials and further multiplication if required. Nearly all of these bulks were late planted and gave no crop in consequence.

Third-Year Lots.—These were confined to re-selections from

Z.1, of which an account was given in my previous report. The whole group was planted on a separate block of land to reduce crossing from outside the strain to as little as possible. Unfortunately, this was new land that had been ploughed for the first time only about eight months before planting. The result of the combination of new land and dry season was a bad crop, and the stand and growth were so poor that little reliable judgment could be formed. All lots appeared to be about the same, except one group from Z.1-24, which appeared rather irregular and somewhat off-type. This group has now been discarded, as it also showed up badly in the yield test described below.

A small amount of selfed seed was obtained from each of the better lots, and this will be enough to keep the strains going in a pure state.

All lots were remarkably free from Jassid, and the whole block remained green, in spite of the poor growth, until cut by the frost in May. A plot of Z.1-9, planted among susceptible types in the varieties collection, showed very good resistance, but was more affected by Jassid than it was in the above block of Z.1 lots. When surrounded by types that are breeding Jassid in large numbers a resistant strain is subjected to a bombardment such as can never occur when it is grown by itself. For this reason it should be less affected when brought into general cultivation.

A variety experiment was carried out in which four promising re-selections were compared against Z.1 Bulk as the standard. The plots were two rows by 120 feet, and each strain was repeated four times, with the standard on both sides of it. This gave eight comparisons with the standard for each strain, on the half-strip method. This was the most that could be planted with the amount of seed available, but it would have been better had a larger number of shorter plots been used.

Growth was rather more even on this plot than elsewhere, but the figures obtained were not very regular. Three of the re-selections showed an increase in yield over the standard, but in each case the mean difference was just too small, as compared with the standard error, to be really significant. The fourth lot showed a decrease on the standard that was significant. This was Z.1-24, the off-type lot referred to above as having been discarded.

A larger scale variety experiment, for comparing Z.1 Bulk with Improved Bancroft, Zululand Hybrid, and Uganda, was also laid down, but the germination and growth were not regular enough to give results of any value.

Of Z.1 Bulk seed, both mixed and re-selected, about half was sent to Parsons for the Magut area, a smaller amount to Wood for Swaziland, and the remainder was planted in the neighbourhood of Barberton. The strain behaved very well and proved markedly resistant to Jassid in all the areas. A number of cases were seen where the local variety was very badly damaged by Jassid, and the neighbouring Z.1 remained green and healthy.

The multiplication plots at Barberton were mostly destroyed by drought, hail, or frost, but a total of about two tons of seed was obtained. There were many applicants for this, and it has been distributed throughout the district. In addition small lots have been sent to growers in areas further afield for trial purposes. In all areas it has been arranged that the re-selected seed will be specially planted for multiplication purposes, the original mixed bulk being continued only until such time as the supply of re-selected seed is large enough for all areas requiring it.

Second-Year Lots.—These lots, with the exception of the Cambodias, were planted early on land that had been fallowed in the previous year. A good stand was obtained, but, as already stated, there was not enough rain till the end of February for real growth to be made. By this time the stand was somewhat reduced, more from the attacks of white ants and other insects than from actual drought. The bulk of the plants were well under a foot in height at the end of the first three months, though occasional plants, or patches, showed a little better growth. On one side of the area, where the soil was slightly more open in texture and allowed better penetration of the rain, the growth was slightly better generally. Excellent growth was made by all after the end of February.

The dry conditions should have given a very good opportunity of judging the strains from the point of view of drought-resistance. The general patchiness of stand and growth, however, made this difficult, though not altogether impossible. One field had been planted with a collection of varieties for judging Jassid-resistance, and this included representatives of the most important selections. The behaviour of the latter, all near together on one plot, was some check on the judgment formed on their allied groups scattered over the main block. Undoubted differences did exist and, speaking very generally, the freer growing and bigger bodied types made less head-way than the smaller ones.

More noticeable than differences in vegetative growth was the variation in fruiting in the early stages. Some groups of selections were decidedly better than others in this respect, and two strains,

A.12 and U.4, were particularly good. These two strains put on quite a number of bolls even before the heavy rain; they fruited very rapidly after it and were carrying a heavy crop by the end of March, at which time many other strains were only just getting going. Further reference to these strains will be made later.

As regards Jassid-resistance the selections followed their previous behaviour very closely, though when placed in order of merit for this character there were some changes of position. Such changes were not large, however, and all lots that had been marked down as of doubtful utility, owing to rather poor resistance, again showed the same failing, whilst good lots were again good.

In deciding which strains to discard great difficulty was experienced owing to the effect of the bad season. It was felt that certain strains that had given poor results would show up much better in a reasonable season, and that it would be unsound to place too much importance on a poor showing in "the driest season for thirty years." Many lots were discarded, however, for what appeared to be good and sufficient reasons, and most of those that were kept are quite promising. Further selections have been made from 49 single-plant lots out of a total of 251 in this group. All of these, with the exception of one or two retained for types only, appear to be sufficiently Jassid-resistant for practical purposes.

As already mentioned, two strains, A.12 and U.4, stood out markedly as able to produce a good crop in very dry conditions. A.12 is a selection made by Mr. E. T. E. Andrews, a keen cotton grower of this district, who very kindly allowed me to take, for testing on the station, some plants from progeny rows he had grown in the previous season. It is a strong, tough type, very hairy and very resistant to Jassid. It fruits freely and holds its bolls well.

U.4 is a rather different type, being decidedly small, compact, and hardy without appearing coarse. It is resistant to Jassid, but not to the same degree as A.12. It fruits and holds its bolls extremely well and, in spite of the small size of the plant and a small boll, gives a heavy yield per plant. A multiplication plot of 1 acre of this strain gave 750 lbs. of seed cotton, a very good yield for the season. The whole crop, put through a commercial gin, gave a ginning percentage of 34.6 and a lint of $1\frac{3}{16}$ inch in length.

The accompanying photographs (Plates I. to IV.) show single plants and plots of A.12 and U.4. The A.12 plot was too far from the camera to show as well as it should have done, but it is just possible to detect large numbers of unopened bolls in addition to the cotton showing.

The following statement gives the average figures for plants from the above strains, mostly selfed, that have been taken for carrying on:

<i>Lot Number.</i>	<i>Number of Plants.</i>	<i>Yield per Plant (Grms.).</i>	<i>Ginning Percentage.</i>	<i>Boll Weight (Grms.).</i>	<i>Weight of 100 Seeds (Grms.).</i>	<i>Lint Length (Mm.).</i>
A.12-1	6	133	34.8	6.1	9.4	30.2
A.12-2	12	163	31.8	6.3	10.2	29.7
U.4-3	9	138	34.8	4.9	9.9	31.6
U.4-4	14	175	36.3	4.8	9.8	32.2

It is very uncertain whether these two strains will maintain the superiority, in comparison with others, that they have shown in this season. Their early bolling gave them a big advantage, as they were less affected by the frost and escaped much of the damage from a late bollworm attack that affected most of the other lots. It is possible that other strains may be as good, or better, in a more normal season. This year's evidence of their drought-resisting qualities is valuable, however, as there are some very dry areas in the country for which they should be particularly suitable. Several other strains did reasonably well, though obviously severely affected by the drought. The most promising of these, together with the above two, are being multiplied in the coming season, and will be put into yield tests in a number of areas in the low veld.

One other selection, Z.106, deserves mention. It is a very close upright type, as will be seen from the photograph (Plate V.), and maintains this habit even when widely spaced. It is very resistant to Jassid and fruits well, having given quite a good yield in the past season, though the spacing, $3\frac{1}{2}$ by 2 feet, was very much wider than appeared necessary. It will be given a trial on several much closer spacings in the coming season to see what is possible in this line.

The Cambodia selections were planted in a separate group and could not be got in till about a month after the main batch. They were too late to be of any use and were completely wiped out. Fortunately, part of the seed of some of the most promising lots had been sent to Wood and Parsons for trying in their respective areas. Some of the seed they produced is being returned to me for carrying on at Barberton. In addition small amounts of reserve seed had been kept, and this will be planted in the coming season.

VARIETIES.

The collection of varieties comprised all those commonly grown in this country, a number of well-known American varieties newly introduced, one or two from other countries, and the most important selections. In all a total of forty-eight lots were planted in one plot, four rows of each, for observation purposes. This was the first plot planted, and a good stand was obtained, but growth started badly and improved later in the same manner as already described for the selections. The chief observations made were concerned with Jassid, and an account of these will be given under that heading.

The general behaviour of the varieties again showed Jassid to be the limiting factor in determining their results. The newly imported American varieties, Delfos, Acala, Express, Mebane, Rowden, Lone Star, Cleveland, and Belton, were wiped out completely, and gave neither growth nor crop. Of these Acala was the worst and Cleveland the least bad. The local Watts Long Staple and Griffin, together with Arizona from Northern Rhodesia and Rustenburg Bancroft, were very little better. The local varieties that are principally grown on the low veld, Improved Bancroft, Zululand Hybrid, and Uganda, were not attacked at quite so early a stage, and made some pretence at producing bolls. They all went off before the bolls were properly developed, however, and gave a negligible crop, Uganda, as usual, being a trifle better than the other two. "Over the Top" from Nyasaland was a good deal affected by Jassid, but produced a small crop. The selections showed up very well and mostly produced a fair crop, some of them being good. Cambodia was undamaged by Jassid, but much broken by wind and so late that the frost cut it before any crop was produced.

JASSID.

Jassid was a good deal later in developing than in the previous season, but it finally reached nearly the same intensity. It is probable that the dryness and general lack of growth in the vegetation of the surrounding veld was responsible for its late appearance. The work on Jassid during the season was mainly on the varieties collection and included counts of nymphs on the leaves, records of the effect on the plants, and counts and measurements of hairs. In addition, counts of nymphs were made on plots treated with various fertilizers to test their effect on Jassid. The above work was carried out by Mr. D. E. A. Gutsche, who held a Corporation Studentship and worked on the station during the season. I wish to record my

appreciation of his keenness and the steady work he put in on the laborious business of keeping these records.

Jassid Counts.—An attempt was made to estimate the relative powers of resistance of the different varieties by recording their degrees of infestation at regular intervals. For each variety a weekly count was made of the number of Jassid nymphs to be found on five leaves of each of six plants. In view of the growth being generally poor and rather uneven these plants had to be selected by judgment. The plants taken were rather better than the average, and as nearly as possible of the same state of growth in each variety. The same plants were used throughout the records. The leaves chosen were as far as possible at about the same stage, fully grown without being old. Some differences in size of leaf existed between the varieties, but this had to be neglected as it was not possible to spare more time for the work.

Side by side with the counts a weekly record was made of the visible effects of Jassid on the same plants. The system of description adopted was a purely arbitrary one that has grown from the original method of describing the apparent damage as *slight*, *moderate*, *rather bad*, or *bad*. More classes have been introduced between these, and a whole series of smaller steps added for earlier stages. It is possible to detect the effect of Jassid long before any reddening of the leaves takes place, and these early stages are important in distinguishing between resistant strains. For purposes of averaging, and for presentation of the results in the form of graphs, the classes used have been given numbers, the higher numbers indicating the greater effect of the Jassid.

The results obtained are most instructive and form a very useful record of the varying degrees of resistance of the different strains. The counts of nymphs are shown in Fig. 1 for varieties and strains covering the full range of infestation. It will be seen that Cambodia remained almost entirely free from Jassid throughout. The next curve represents the mean for the two most resistant selections, A.12 and Z.106. Here the numbers were insignificant for the greater part of the time and still very small at their worst. The third curve gives the mean for the five next best selections. This group, which includes Z.1-9 and U.4, represents a standard of resistance that is probably as high as is actually required in practice. The curve compares very well with the one that follows—viz., the mean for Improved Bancroft, Zululand Hybrid, and Uganda, the three local varieties most commonly grown. It will be seen that the selections show a much smaller and much later attack than the local varieties.



PLATE I.—ANDREWS 12

A typical plant showing good fruiting.



PLATE II.—U. 4/2/6
A typical U. 4 plant, excellent fruiting.



PLATE III.—ANDREWS 12

Very resistant to Jassid, very good cropper, lint $1\frac{3}{8}$ ins.



PLATE IV.—U. 4

Resistant to Jassid, wonderful cropper, lint $1\frac{3}{4}$ ins.



PLATE V.—Z. 106/5

A compact, upright type, suitable for very close spacing.

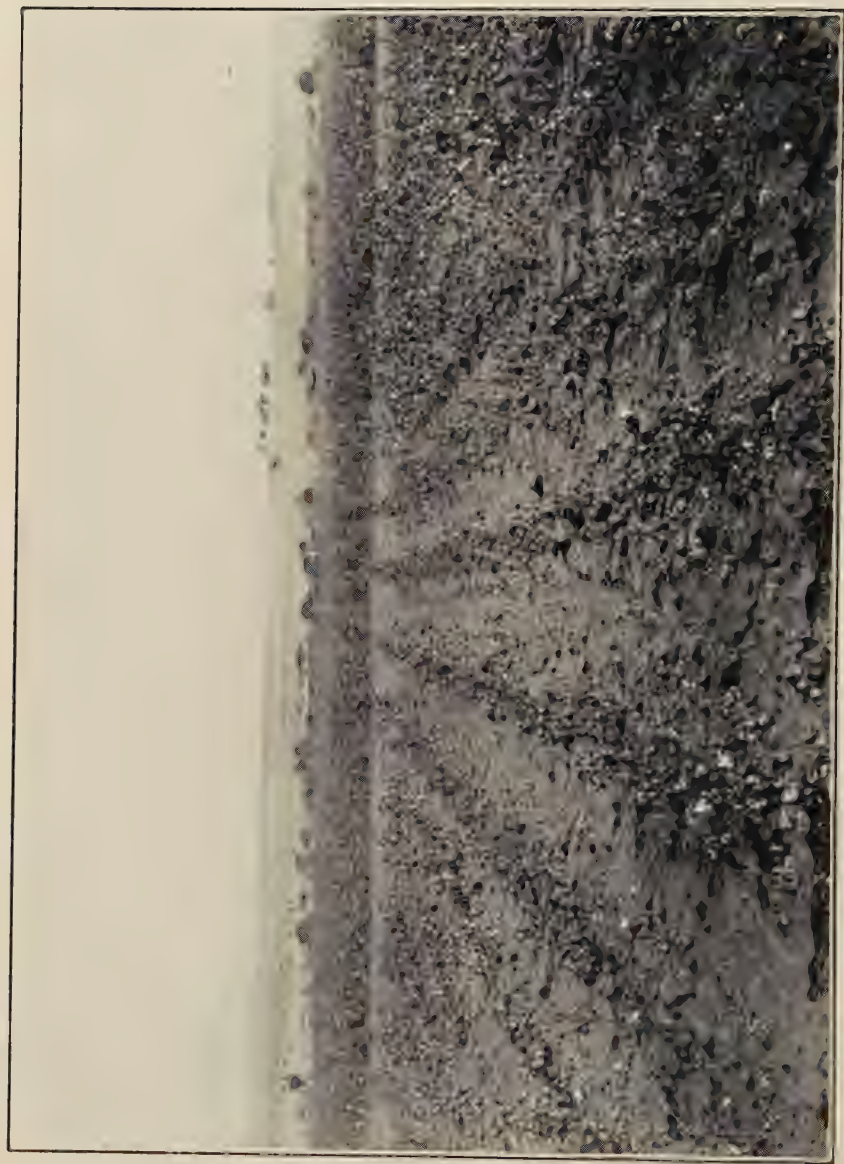


PLATE VI.—ACALA (FOUR ROWS)

Entirely destroyed by Jassid.

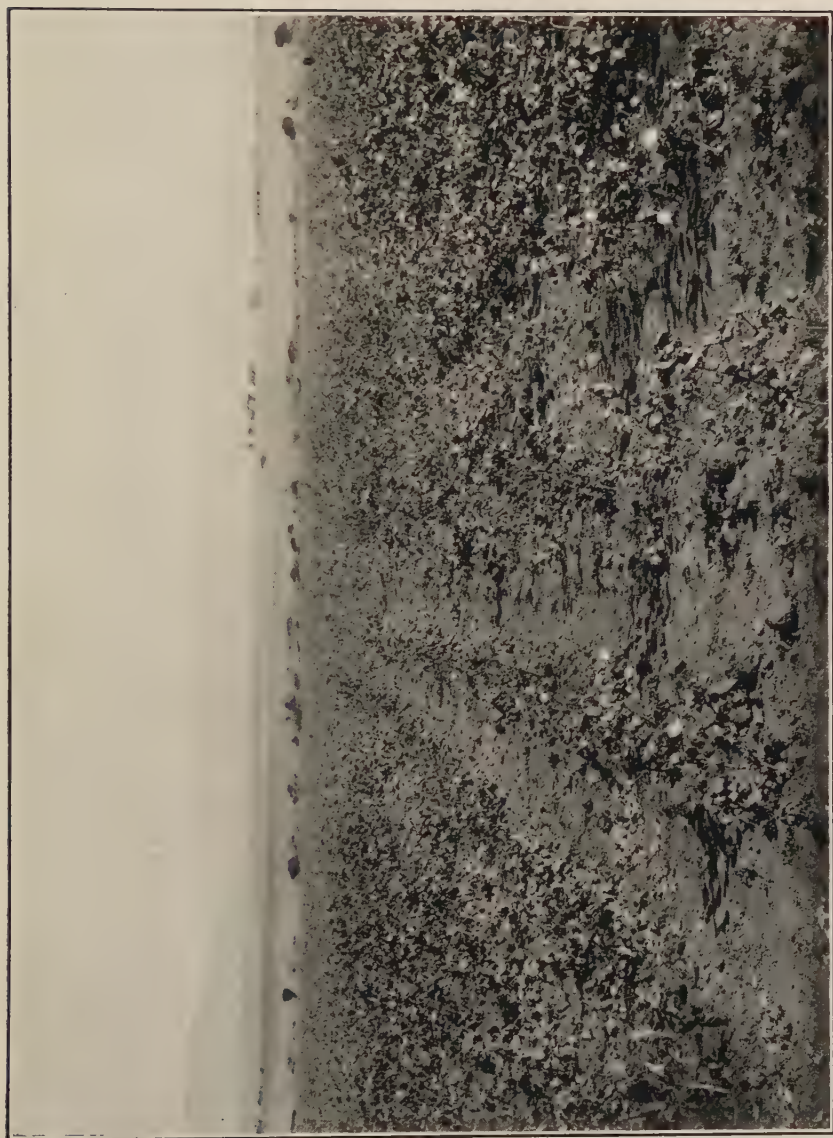


PLATE VII.—BARBERTON COMMERCIAL BANCROFT (FOUR ROWS)

Crop reduced by Jassid to practically nothing.



PLATE VIII. U. 4 6 (Four Rows)
A really good crop.

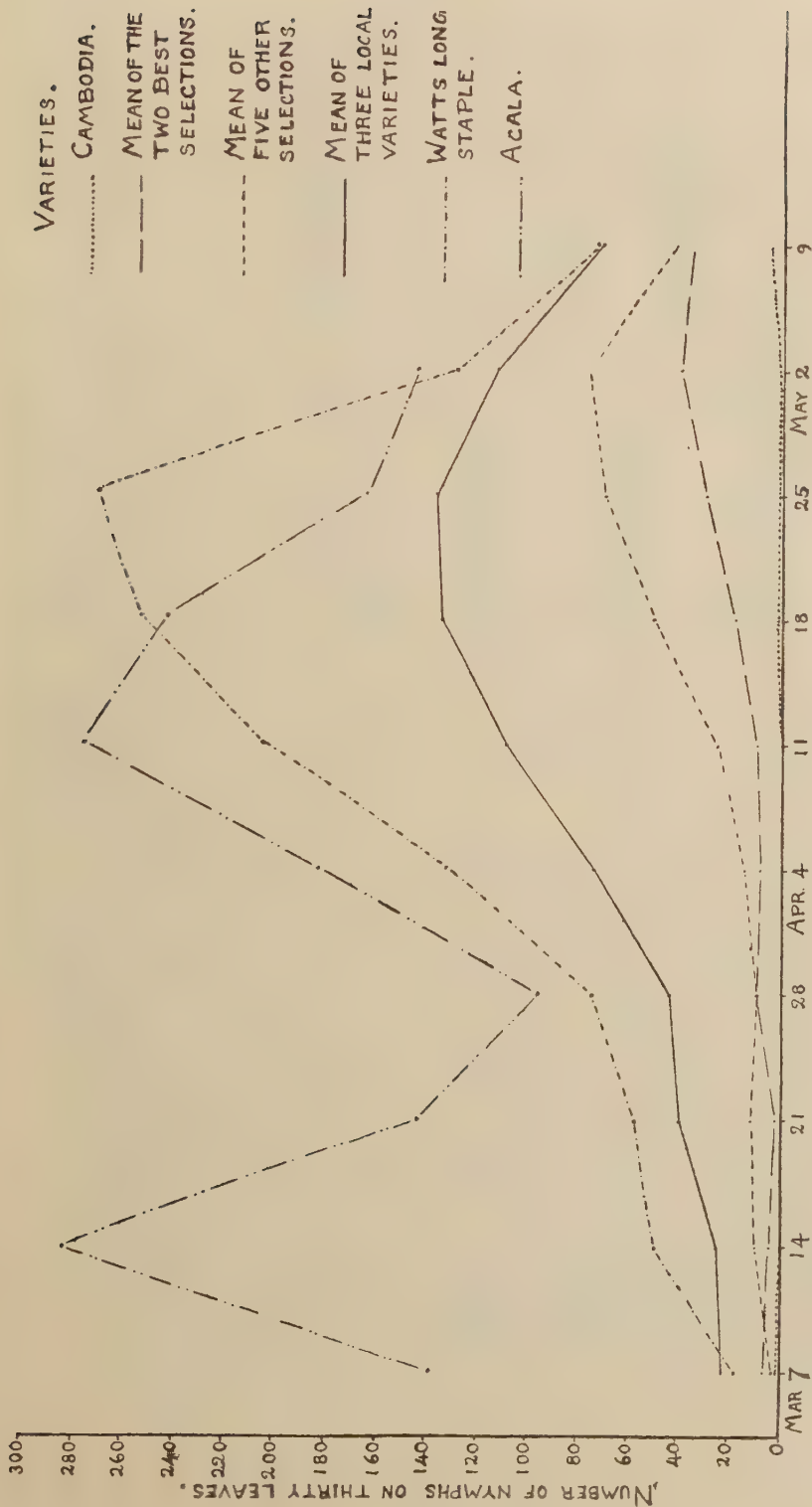


FIG. 1. WEEKLY COUNTS OF JASSID NYMPHS ON THIRTY LEAVES OF DIFFERENT VARIETIES.

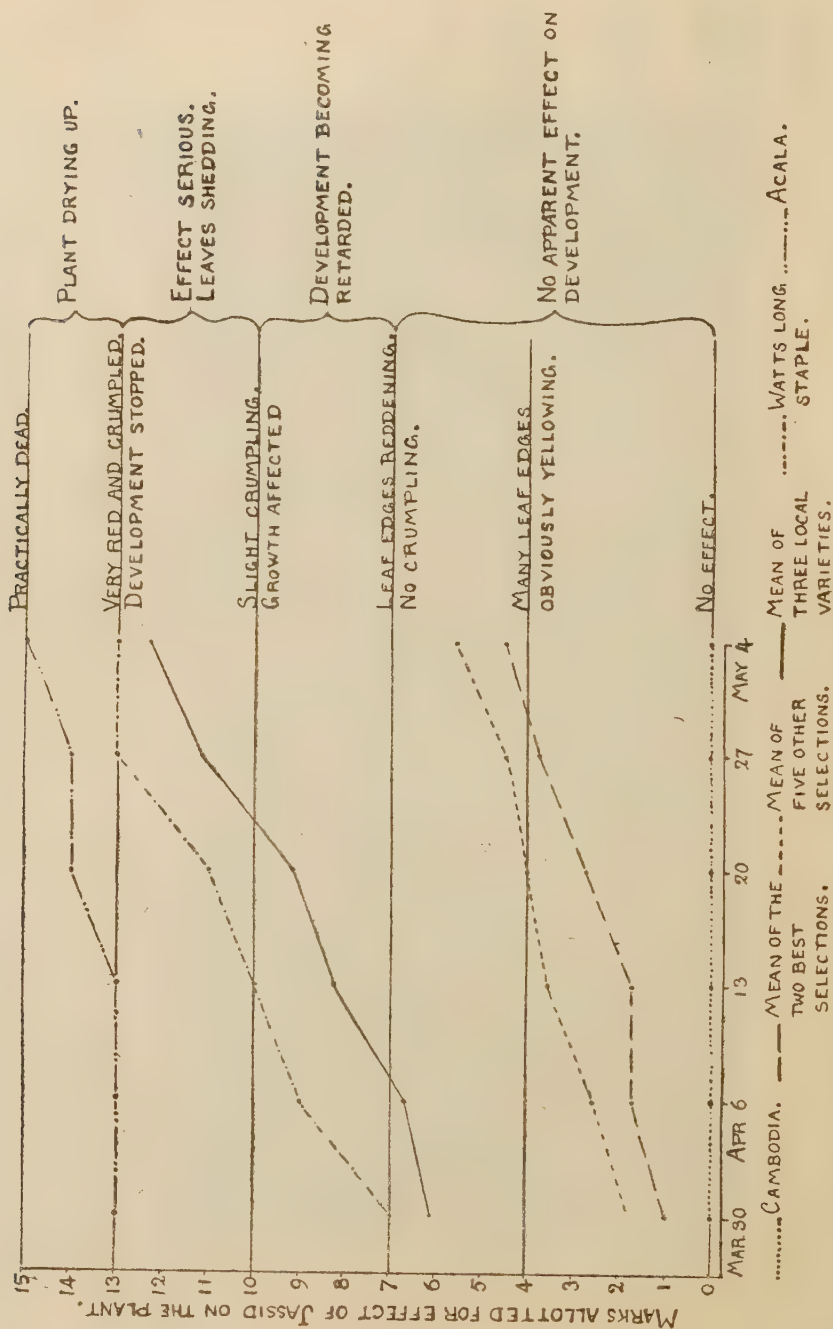


FIG 2. EFFECT OF JASSID ON DIFFERENT VARIETIES.

The time of the season at which Jassid develops is of vital importance from a practical point of view, since the later it comes the less crop will be lost or damaged.

Watts' Long Staple is particularly susceptible and has been given up entirely in Jassid areas owing to this fact. The figures clearly show the infestation that it suffers. All the newly imported American varieties gave very high numbers, Acala being the worst. The curve for this variety shows an enormous early infestation followed by a big drop and a later rise. The most likely explanation appears to be that the plants became so bad at an early stage that Jassid ceased to breed on them, and that a new attempt at growth, at a later stage, led to a new increase in the numbers of nymphs.

The effect of Jassid on the plant is shown in Fig. 2 for the same set of varieties. If the two figures are compared it will be seen at once that a close correlation exists between numbers of nymphs and condition of the plant. The superiority of the selections is very marked, and it will be seen that they went through the critical part of the season practically undamaged. They showed more effect at a later stage than is included in the curves, but by that time they were opening their crop and ripening off. The three photographs given (Plates VI.-VIII.) show Acala, the local Bancroft, and U.4 at picking time, the end of May. The practical value of resistance to Jassid is very obvious. It is true that U.4 is a very free cropper, but it was its resistance to Jassid that enabled it to develop and ripen its crop properly.

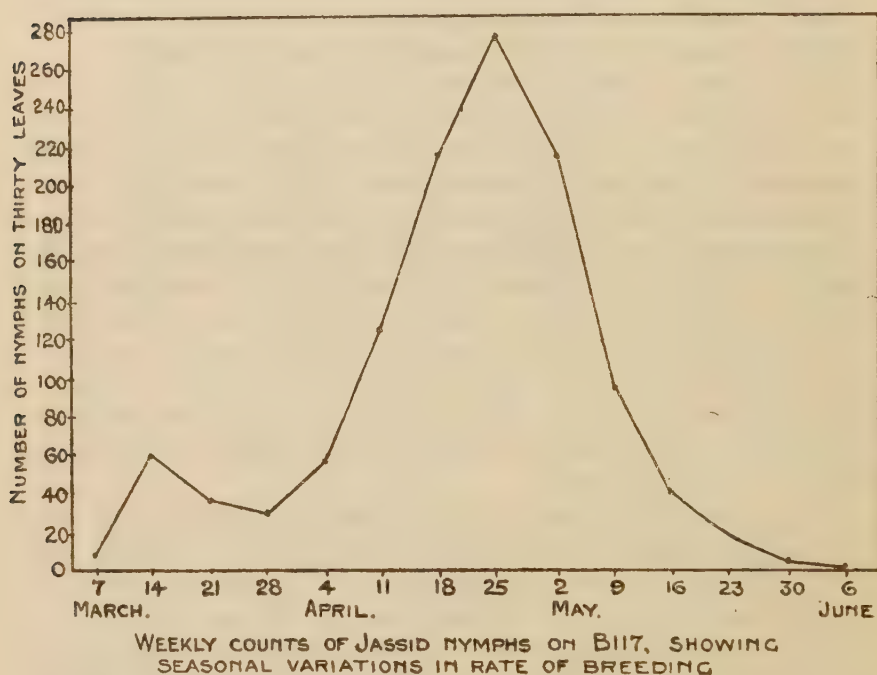
The seasonal variation in the prevalence of Jassid nymphs can be judged to some extent from the curves in Fig. 1. Most of the strains there represented were defoliated by frost in the middle of May, however, hence the full curves are not shown. One strain, B. 117, kept as a type, gave a very regular curve, which is shown in Fig. 3. It is a coarse, big-leaved type, and was heavily infested without going off badly enough to discourage breeding. It escaped the frost and good figures were obtained for the whole period; this curve, therefore, should be a good indication of the seasonal rate of breeding of the Jassid for this year. It shows a rapid rise in numbers from late March to a maximum at April 25, and a rapid decline from then till the end of May, when the numbers became negligible. It will be noticed that a small peak exists at March 14. This corresponds with the large peak for Acala in Fig. 1, but the suggested explanation in the latter case could not apply to B.117.

Fertilizers.—A series of plots was laid down once more to test the effect of different fertilizers on the susceptibility of the plant

to Jassid. There were two repetitions of each of the following treatments: chloride of potash at 250 lbs. per acre, superphosphate at 500 lbs., nitrate of soda at 300 lbs., a combination of all three, in the ratio $K_2:P_5:N_3$, at 1,000 lbs., Guano at 1,000 lbs., and Nil. The fertilizers were all broadcast and hoed in some time before planting, and Watts' Long Staple was planted uniformly over the area.

The early growth was poor, as with everything that was planted. Jassid was already in the crop early in March, when growth should

FIG. 3.



have been rapid after the good rains, and the plants never really got away. No regular differences could be detected in the growth on the different treatments, and Jassid was uniformly bad throughout, the whole area giving no crop worth picking.

Counts of nymphs were made every fourth day on five leaves from each of twelve plants, two groups of six on every plot. The figures show no appreciable differences between the treatments, but a very steady rise in infestation throughout. A point of interest that emerged, quite accidentally, was that the presence of aphid on a plant meant few or no Jassid nymphs. This was repeatedly observed, and the nymph counts for half the area were vitiated by occasional patches

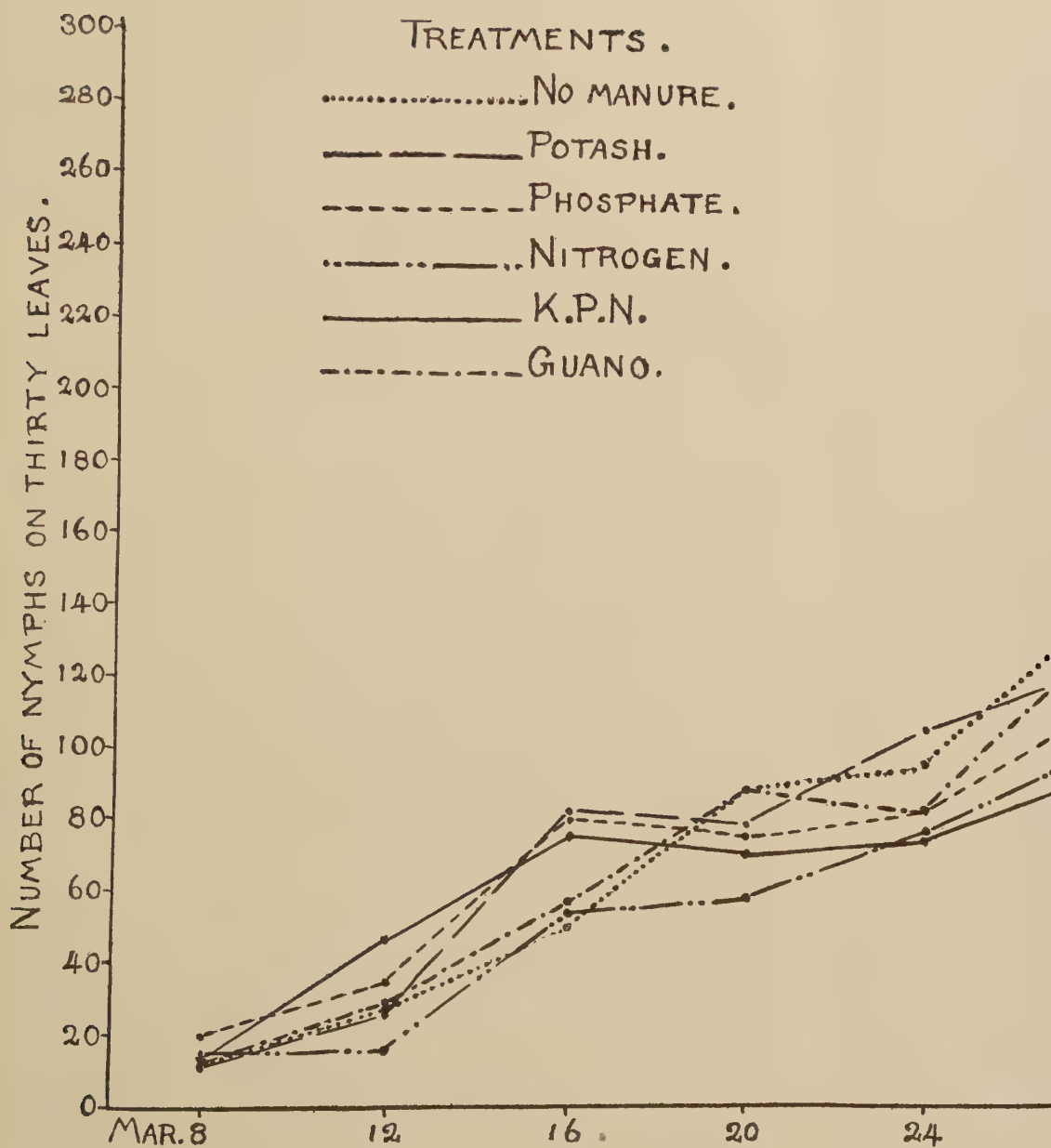
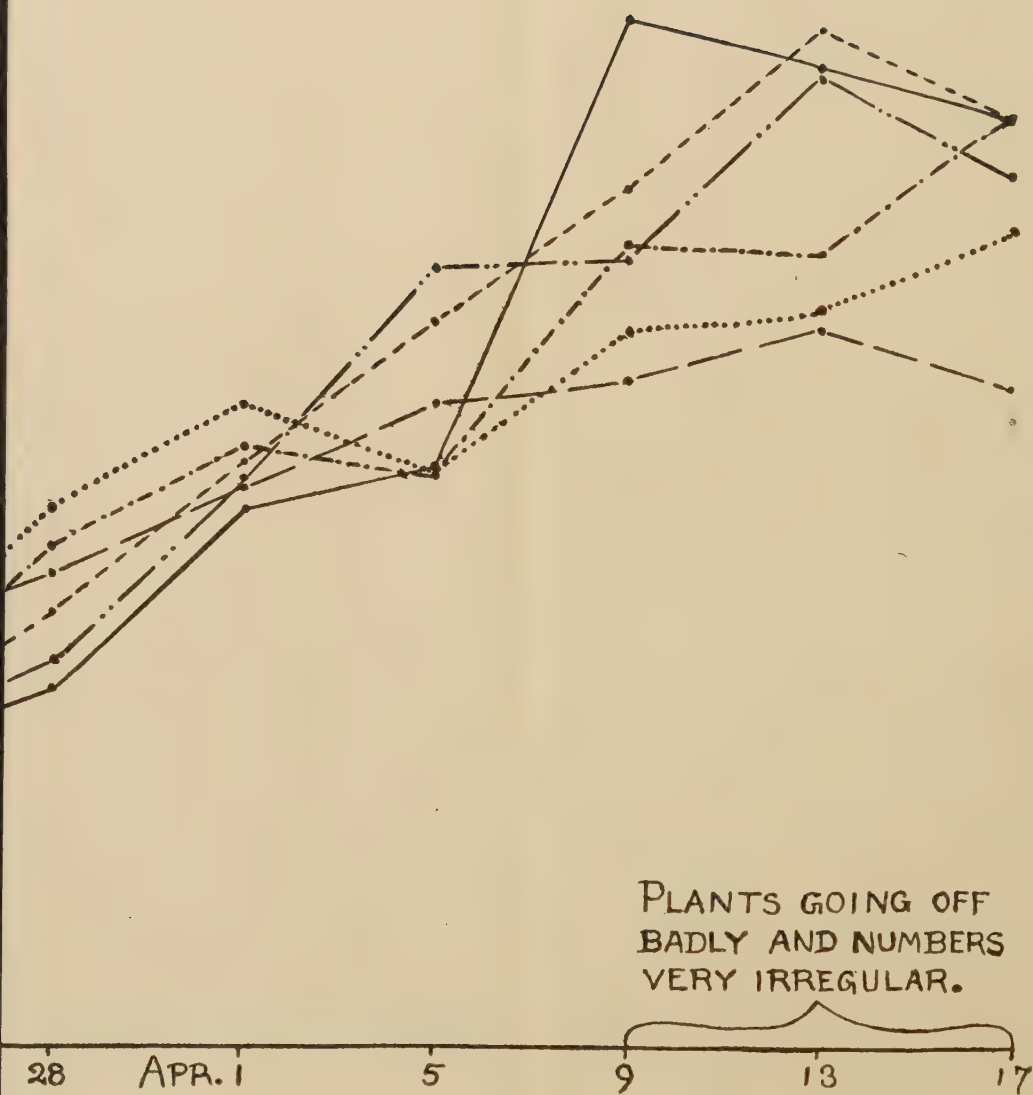


FIG 4. COUNTS EVERY FOURTH DAY OF JASSID NYMPHS
(MEANS OF TWO GROUPS OF SIX PLANTS, FIVE LEA



ON FERTILISER PLOTS OF WATTS LONG STAPLE .
 (LEAVES PER PLANT.)

affected with aphid. The curves given in Fig. 4 represent the figures obtained from half the area, two groups of six plants for each treatment, that was quite free from aphid. The last three counts were made when the plants were going off badly; the numbers were consequently irregular, and any differences that appear probably mean nothing. It is obvious that the fertilizers did not affect the susceptibility of the plants, but it is still uncertain what would have been the result if good growth had been made before the Jassid got a hold.

Hairiness.—Some further work was done on the connection between hairiness and Jassid-resistance. Measurements were made of the density and length of hairs on the under side of the leaf for a number of strains. Unfortunately, the work could not be started till rather late in the season, and it was impossible to give as much time to it as proved necessary for obtaining really reliable figures for density.

A simple method was devised for taking definite areas of leaf surface in counting hairs. A strip of leaf, pressed between two slides, was placed under the microscope, and all hairs showing on the field were counted as the strip was moved along for 20 mm. by the mechanical stage. The visible field was about 2 mm. in diameter and the area was, therefore, roughly 40 square mm.

Four such areas were examined on each strip of leaf and two leaves from each of three plants were taken from each strain. The leaves were all as nearly as possible of the same condition, just fully mature, and the strips were taken between two main veins towards the base of the leaf. It was found that there was often an appreciable difference between the numbers of hairs for different plants of the same strain, and more plants should have been taken for really reliable figures to have been obtained. For this reason the actual figures are not given.

In measuring hair-length the same strips of leaf were used. The result of pressing between slides was that the hairs lay flat in the field and could be measured easily with an eye-piece micrometer. Thirty hairs were measured on each area, and the mean figures obtained appeared to be reliable. As both length and density of hairs are connected with Jassid-resistance it is useless giving one set of figures without the other. Actual figures will not be given, therefore, until further more accurate work has been done.

The results, as far as they go, leave no doubt that both density and length are concerned. Thus Cambodia, with a low density, has very long hairs and is highly resistant. A.12 and Z.106, very

resistant types, both show high density and long hairs. Watts' Long Staple and Delfos, very low density and moderate length, are very susceptible. Acala is the lowest density of all types examined, about one-tenth of that for A.12 and Z.106. No type has yet been found with a high density and very short hairs.

SPACING EXPERIMENTS.

An experiment was laid down, with replicated plots, to test the yield from different spacings. The land used was part of the same new block that failed to give a crop in the case of the Z.1 selections. Germination and growth were poor and irregular, and the experiment was abandoned.

A separate experiment, for analyzing the effect of different spacings on the development of the plant, was somewhat more successful, though still not good enough to merit a detailed presentation of the figures obtained. This area suffered from drought less than others, but growth was not sufficiently uniform to permit of a random selection of plants for measurements, etc. The variety planted was Z.1-25, and the spacings employed were 6, 12, 18, and 24 inches.

In height of growth the 18 and 12 inches were always ahead and about equal. The 12 inches started about the same and fell off slightly as time went on; there was no great difference, however. The 6 inches started lower and fell off more and more, finishing at a good deal less than the other three.

Flower counts, for equal lengths of row, showed that the 6 inches started most quickly, then 12 inches, and lastly 18 and 24 inches about equal. All spacings became about equal after three weeks, March 3, and the three wider lots kept together thereafter. These three lots gave a curve showing two very definite peaks, about equal, at March 15 and April 5, with a big depression between them. The 6 inches curve was similar, but fell considerably lower in this depression and did not join the others till flowering was going off towards the end of April.

The record of bolls, harvested at weekly intervals, shows the three wider spacings near together throughout, whilst the 6 inches is far behind for every picking. The flowering and bolling figures show that the 6 inches ripened far fewer bolls in proportion to flowers produced than did the others.

It was obvious that the 6 inches spacing was too close for the proper growth and fruiting of the plants. From a practical point of view, there was little to choose between the three wider spacings.

ROTATION CROPS.

Small plots were put in of a number of different crops that may possibly be of use for rotation with cotton. No serious tests were attempted, the main idea being to see how they appeared to shape in the conditions of the district. It was a bad season for the purpose generally, though such crops as came through successfully may be considered to be quite safe for the area as far as resistance to heat and drought is concerned.

The most commonly grown cereal in the low veld is maize, though the ordinary yields are very poor. It really requires better soil and rainfall than are common in the area. Both Kaffir Corn (*Sorghum vulgare*) and Bullrush Millet (*Pennisetum typhoideum*) would appear to be much more suitable crops for the prevailing conditions. The former is occasionally grown by European farmers, though more by natives who use it for making beer. *Pennisetum* is much less common.

A collection of nine varieties of South Indian sorghums was obtained from the Millets Specialist at Coimbatore. These were planted on small plots alongside three varieties that are found in South Africa. Planting was very late, and the local varieties made no headway and gave practically no crop. The new varieties were obviously more at home in the hot, dry conditions and made very good growth. They were late, however, and only the early maturing ones gave a reasonable crop. Sufficient seed was obtained from all to plant bigger plots in the coming season.

Two plots of *pennisetum* were put in, one from seed obtained locally and one from Nyasaland. Both stood the conditions well and gave a good crop. No difference could be detected between them.

The groundnut is a very likely crop for rotation purposes. It has been tried in various parts of the area and has given very good results in places. The common variety grown is Virginia Bunch. A collection of nineteen varieties was obtained from Southern India, through the courtesy of the Economic Botanist, Coimbatore, and one from Ducker in Nyasaland. These were all planted rather late, and were too badly hit by the conditions to give good results. Seed of all was obtained for planting larger plots in the coming season.

Various beans and pulses were tried, but the only ones that were at all successful were Mung (*Phaseolus mungo*) and Cowpea (*Vigna catjang*). Both of these look like being very suitable crops for the area.

Two varieties of sunflower were planted and did remarkably well. They were noticeably less affected by the drought than most other crops, and the better one, a grey-seeded variety, gave a yield of over 1,300 lbs. per acre on a one-sixth-acre plot.

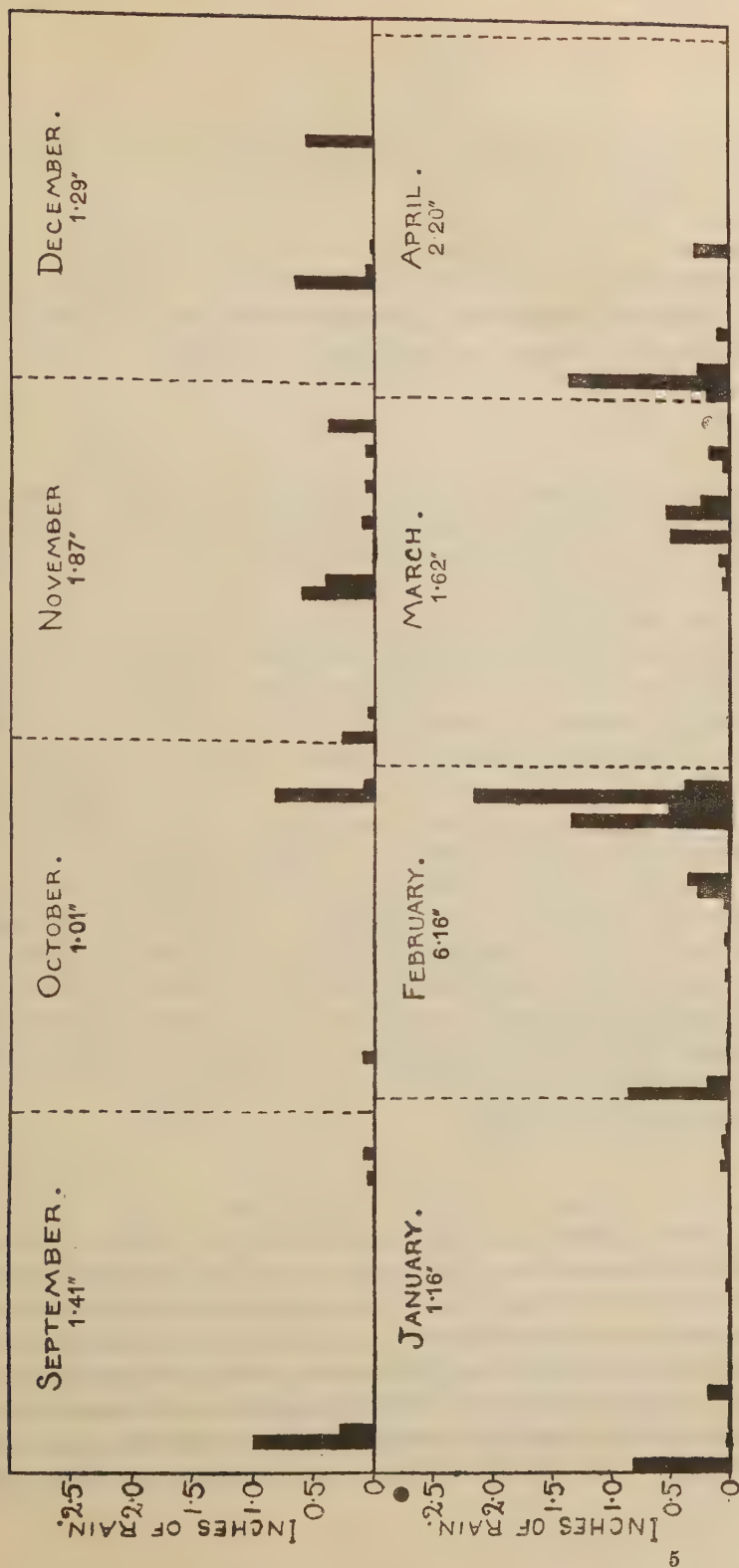
Sesamum, which had done rather well in the previous season, was almost a complete failure. It did not grow until after the good rain, late in February, and was cut by the frost before it was ripe in May.

DAILY RAINFALL, SEASON 1926-27.

	<i>July.</i>	<i>Aug.</i>	<i>Sept.</i>	<i>Oct.</i>	<i>Nov.</i>	<i>Dec.</i>	<i>Jan.</i>	<i>Feb.</i>	<i>Mar.</i>	<i>Apr.</i>	<i>May.</i>	<i>June.</i>
1	—	—	—	—	0.25	—	0.82	0.87	—	0.19	—	—
2	—	—	—	—	—	—	—	0.19	—	1.35	—	—
3	—	—	1.00	—	0.04	—	0.01	—	—	0.27	—	—
4	—	—	0.27	—	—	—	—	—	—	—	—	—
5	—	—	—	0.10	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	0.10	0.06	—
7	—	—	—	—	—	—	0.18	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	—	—	—	0.66	—	—	—	—	—	—
10	—	—	—	—	—	0.05	—	—	—	—	—	—
11	0.40	—	—	—	—	—	—	0.02	—	—	—	—
12	—	—	—	—	—	0.02	—	—	—	—	—	—
13	—	—	—	—	0.60	—	—	—	—	0.29	—	—
14	—	—	—	—	0.40	—	—	0.02	—	—	—	—
15	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	0.01	—	0.05	—	—	—
17	—	—	—	—	—	—	—	0.03	0.02	—	—	—
18	—	—	—	—	—	—	—	0.27	0.09	—	—	—
19	—	—	—	—	0.10	—	—	0.35	—	—	—	—
20	—	—	—	—	—	—	—	—	0.50	—	—	—
21	—	—	—	—	—	0.56	—	—	—	—	—	—
22	—	—	—	—	0.05	—	—	—	0.53	—	—	—
23	—	—	—	—	—	—	—	—	0.23	—	—	—
24	0.09	—	—	—	—	—	—	1.34	—	—	—	—
25	—	—	0.05	—	0.06	—	—	0.52	—	—	—	—
26	—	—	—	—	—	—	0.06	2.17	0.04	—	—	—
27	—	—	0.09	0.82	0.37	—	0.03	0.38	0.16	—	—	—
28	—	—	—	0.09	—	—	0.04	—	—	—	—	—
29	—	—	—	—	—	—	0.01	—	—	—	—	—
30	—	—	—	—	—	—	—	—	—	—	—	—
31	—	—	—	—	—	—	—	—	—	—	—	—
Totals in Inches	0.49	—	1.41	1.01	1.87	1.29	1.16	6.16	1.62	2.20	0.06	—

Total rainfall for year, 17.27 inches.

DAILY RAINFALL. SEASON 1926-27.



REPORT ON THE WORK OF THE COTTON EXPERIMENT STATION, CANDOVER ESTATES, MAGUT, NATAL, FOR THE SEASON 1926-1927

BY

F. S. PARSONS.

IN the 1925-26 Report from this Experiment Station, brief mention was made of a new area secured for experiments. The block finally selected is 73 acres in extent. The land had borne two crops of cotton before being taken over.

The soil is mainly composed of a well-broken-down shale loam of good depth, overlying semi-decomposed shale layers of a soft flaky nature, apparently capable of absorbing and retaining a good storage of moisture. The loss on ignition, from an air-dried composite soil sample taken from twenty-five field samples of the top foot, was 9.5 per cent. The active pH of the soil is 7.2. It is deficient in total phosphoric oxide, this being 0.06 per cent.; available phosphoric oxide is 0.0034 per cent. by conventional analyses.

The buildings on the Station at present consist of an office-shed and one storehouse. It is proposed to erect, during the coming season, a native compound and implement shed, part of which may be utilized for the storage of seed, other than cotton, in metal containers permitting proper fumigation. In addition to the housing erected for Mr. Keatinge, who took up his appointment in November last, a second large stone and thatched rondavel has been provided nearby for Mr. Bowmaker.

CLIMATIC CONDITIONS.

In the Magut and neighbouring areas exceedingly poor and infrequent rains have been experienced. A few local farmers, however, recorded better rains than their neighbours, and in one or two cases the crop returns were surprisingly good. The topography of the country plays a very important part in the precipitation of rain. In the Empangeni-N'tambanana district of Zululand, 200 miles to the south, good rains fell, and an excellent cotton crop has resulted.

The fact that the second season's work has been conducted under

conditions of severe water stringency is most disappointing. Farming in general has been very difficult, and one must pay tribute to the faith, optimism, and perseverance of the farming community. One may also pay tribute to the cotton plant, which has grown and cropped under extraordinarily adverse weather conditions; in fact, better than any other cultivated annual crop.

In this connection it is instructive to examine the rainfall of previous years, and readers are referred to the chart included at the end of this Report depicting the annual rainfall for the past nine years. The measurements have been recorded at Magut itself, which is a kopje at 2,300 feet elevation above sea-level. The elevation of the cotton lands is probably 1,500 feet, and the author's experience is that the falls on Magut hilltop are invariably rather heavier than the generality of records taken in the valleys below. Making allowance for such difference, it is evident that the rainfall from 1918-25 has been decidedly heavier than during the seasons 1925-26 and 1926-27. It would appear that the late introductory years of cotton growing (the district has only been cultivated widely for four years) have coincided with unusual conditions of rainfall. The season about to commence may well see a return to the experience of 1918-24. A recurrence of the very wet March of 1925 is highly improbable.

The effective rainfall recorded at the Experiment Station during the past season was 13.6 inches. No soaking rain fell at any period. The heavy and late falls of 1925 provided subsoil moisture, which was the main factor in carrying through the 1925-26 crop, providing it was sown with October rains of that season. Last season's crop started with no such subsoil moisture, and was at all times in danger. Shallow rooting was, of course, general. The onset of flower buds, brought about by the short rains at intervals (*vide* chart), rapidly gave place to (relatively) enormous shedding under increasing water stringency, and the crop history was largely one of false starts.

The best rains appear to come from clouds accumulated over the Indian Ocean. Many times during the season rain seemed imminent, but a change of wind direction carried off the clouds. Hot, scorching winds were a prominent feature of the season. These are referred to later in connection with wind breaks.

Two severe hailstorms (a very unusual occurrence according to the records) fell in late November. Fortunately, the erratic course of the main path of the hail missed the Experiment Station, but a seed multiplication area, adjacent to the Station, suffered severe damage from both storms.

TEMPERATURES (DEGREES F.).

1926-1927.	<i>Modal Maximum.</i>	<i>Modal Minimum.</i>	<i>Hottest Day.</i>	<i>Coldest Day.</i>	<i>Mean Soil Temperature.</i>
November ..	85	57	104	52	77 (two hail storms in late Nov.)
December ..	88	60	105	58	80
January ..	90	65	104	60	81
February ..	87	65	103	60	81
March ..	85	60	95	58	80
April ..	82	57	89	48	79
May ..	78	50	83	41	69 (frost on May 5)
June ..	74	44	80	39	65

PROGRAMME.

PHOSPHATE FERTILIZER EXPERIMENTS.

The standard phosphate manurial trials referred to in last year's report, which the author is supervising for the Department of Agriculture in the district, have again failed to give measurable yields.

Five progenies from single plant selections out of Family C-8, a Cambodia strain selected by Mr. Parnell, Barberton Station, were sown in progeny rows, and pedigreed on the Webber-Harland system. Much was hoped from these lots, and although the results were not equal to expectation, it is believed that promising material will result from re-selections that have been made at Mr. Parnell's request.

SEED MULTIPLICATION.

By arrangement with local growers, widely separated areas, totalling 300 acres, were sown by hand with some 350 lbs. of seed from the jassid-resistant strains produced by Mr. Parnell, Barberton Station. Hail and drought ruined some 200 acres so planted. Fortunately seed from the most valuable re-selected material had been set out on fallowed land, which benefited from the rain running off the surrounding hills. These lots gave 6,000 lbs. of seed, a multiplication of 120 times. The total multiplication from a bulk lot of seed (300 lbs. sown) was 3,161 lbs. This represents the yield from one field which escaped hail and the worst of the dry weather. In the sowing of the above primary areas, all other considerations were sacrificed to maximum multiplication. Single seeds were sown at approximately a yard interval.

A distribution of the seed for further multiplication has been made.

Large quantities have been apportioned, under certain reservations, to farmers within a day's journey from the Experiment Station. Parcels of seed (25 to 50 lbs.) have been sent to planters throughout Zululand, and a portion of the seed has gone into the Barberton district. The reservations mentioned refer to the future distribution of seed produced from any one of four re-selected lots. It is expected that the multiplication of these during the coming season will furnish sufficient seed to plant the entire cotton area by machine.

Nineteen strains were set out in a block adjacent to the Experiment Station. These were for observation and multiplication purposes. This field suffered two severe hailings, which did not affect the Station. The stands were ruined in consequence of the hail and a violent downpour of rain. Some observations of value, however, were made on the scattered remnants. During the growth, and specially during bolling, the Barberton strains were a source of encouragement to parties of cotton growers who visited the fields.

Means have been devised whereby large quantities of seed sent out for further multiplication may be thinly sown by machine. This is desirable, as uniformity of sowing depth and packing about the seed may be secured to better advantage with machine planting. Experience has shown the necessity for rapid planting following the germinating rain. A planter should be engaged in sowing as soon as the condition of the land permits. It is probable that sowing by moonlight or flares would prove quite practicable on many occasions, following rain. The time and moisture saved would permit Estates working large areas to secure a better stand. Planting operations are too frequently conducted on dry soil, or on the thin borderline of germination possibility, on the plea that the area to be seeded is so large, and the equipment, labour, etc., insufficient.

COTTON SPACING EXPERIMENTS.

These consisted of eight drill interval treatments. The plots were set out on an 8 by 8 balanced chessboard system. A perfect stand was not secured with the sowing rain, and refills could not be induced to germinate under the fleeting moisture conditions. Hand watering was out of the question, and from the outset the experiment was not promising. The plants did live and make growth, apparently on nothing, and, revived by November rains, set a fair crop of flower buds. These were 100 per cent. infested by Sudan bollworm, and the experiment was abandoned, except as a site whereon to capture bollworm moths.

TIME OF THINNING EXPERIMENT—COTTON SEEDLINGS.

A preliminary note on some observations recorded on plots thinned at 4, 6, 8, 10, and 12 inches was published in the *EMPIRE COTTON GROWING REVIEW* last October. The experiment was conducted to gauge the plant relief, if any, induced by the elimination of competition in seedling rows, at an early stage. Under the conditions experienced, distress was notably relieved, and increased growth followed. It is believed that this measure may be adopted to stimulate growth in late planted cotton. It was observed that the earlier fruiting produced by earlier thinning disposed the plants to heavier bollworm damage from the Spring infestation.

TIME OF PLANTING EXPERIMENTS.

The uncertain spring rains and their distribution probably render any attempt to fix an optimum planting period rather futile. The volume of the individual planting rains, whenever they may have fallen, from late September to late November, coupled with the subsoil moisture conditions, have been of greatest importance during the last two seasons. In the season under review, no useful carry over of subsoil moisture could be expected, and early rains were light. The growers had to take the chance of planting with the first reasonably good fall which occurred in October or November, the two months in which the bulk of the planting has always been done in the past.

From the rainfall charts for the years 1918-19, 1919-20, and 1923-24, it is evident that no germination could have occurred before November. In 1921-22 the good rains in early September would have carried the crop on to meet October rains, but the earliest rains appear to be somewhat isolated, and are no doubt of more value for the better preparation of seed beds and as weed seed germinators.

One main object of the experiments was to learn the probable latest date of planting from which fully fruited crops may be expected. Frost is a consideration here, although not severe as a rule except on bottom lands. Frost may come in May, as was the case last season, but more usually in July. The interest in the latest planting date arises because of (1) protracted spring drought; (2) insect pest periodicity; (3) hail, wind, and rain destruction of early planted stands; (4) pre-cropping—*i.e.*, rapid green manure or partial fallowing to conserve the moisture of early rains.

It may be stated now, however, on the basis of two dry seasons' observations, that mid-December is almost certainly too late to plant except for forcing lands—*e.g.*, sandy loams. For the previous

seven years, good rains have fallen in February, March, and in some cases, April, and it is apparent that these rains would prolong the ripening off processes, and expose the fruit to internal boll disease unduly; the stainer appears in great numbers in March. The boll maturation periods, taken from late February, March, and April flowers, range from 70 to 100 days. The temperatures in June and July drop to about 39° to 41° . Apart from boll disease, late fruiting bolls do not open properly. An examination of the bolls borne by December and January-planted cotton on the 6th of July showed these to be practically 100 per cent. diseased. These bolls comprised the main crop set by these plantings.

The time of planting plots were 1/40 acre areas in triplicate, and distributed at random on the site. The dates of planting were: October 4, November 3, November 16, November 30, December 10, December 22, January 22, all following not less than 0.70 inch of rain immediately before planting.

The December and January plantings produced no measurable yields. It was evident from a study of the plots that the November plantings encountered less bollworm. So many other factors have influenced plant behaviour in this difficult season that any figures for yield must be viewed with caution. The yields for November 3 and November 16 plantings were respectively six and four times greater than for the October planting. Bollworm was decidedly less in January and February over the whole area, an observation which was also recorded last year. It is evident from the notes on the November plots that they escaped the worst of the spring infestation, as they were not disposed to attack to the same degree as earlier sown cotton by virtue of bearing relatively small quantities of flower buds in comparison with the observed condition of the October plots. These lost practically the whole of the buds set over the months of November and early December, when the main crop was laid down. These observations are borne out by the terrific bollworm infestation on the adjacent spacing experiments, which were also planted on the October rainfall, and by the records in the thinning experiment. The 4-inch thinned plots in that experiment were stimulated to increased budding, and increased bollworm was observed.

The rainfall records show the possibility of storing considerable moisture prior to seeding in late October or November.

The possible relationship between bollworm and sowing date and the incidence of boll disease will form the subjects of future observation.

SOIL MANAGEMENT NOTES.

It is of first importance to secure a good stand, and to give the seedling opportunity to root well. Experience has shown that, given a fair start, the young plants will withstand long periods of dry weather without obvious distress.

The usual local practice is to harrow the land once or possibly twice shortly after spring ploughing, and to plant dry or following rain without further harrowing operations. It seems desirable, however, to harrow the soil immediately before planting, on rain. A portion of the Experiment Station devoted to a commercial crop of cotton was utilized to examine the value of harrowing in front of the planter as a means of moisture conservation. This area is divided into an Eastern and Western Block by a road. Both blocks were treated in the same fashion, with the exception that the Western Block alone was harrowed immediately before planting on a germinating rain, on November 4. The whole had last been harrowed in early October. The Eastern Block was planted on November 4, over the October harrowing.

Western Block yield	..	..	260 lbs. seed cotton per acre.
Eastern Block yield	..	..	207 lbs. seed cotton per acre.

The superior vigour of the crop on the Western Block was quite obvious. Two hundred and sixty pounds per acre is not a profitable return, but the crop was produced on 13 inches of rain, badly distributed. In a somewhat better year, the increased yields that may arise in this way might well represent the profit portion. The area dealt with amounted to 21.8 acres. It would be difficult, if not impossible, to secure the necessary implement treatment on a plot scale. It is felt that the difference in yield is sufficiently wide to be suggestive.

Summer Fallow.—Clean fallowing has not been practised in the area. It is a measure which has often been suggested to farmers in the district as a crop insurance. A portion of the Experiment Station was fallowed during the past season. The land was harrowed after the heavier rains, and a proper mulch maintained. Weeds were kept at a minimum. The winter temperatures are high, strong drying winds prevailing during the winter months. The spring moisture content of the fallowed land is of chief interest. The fallow block, and an immediately adjacent block which had borne cotton in the previous season, were sampled at 18-inch depth for moisture

determinations on September 21. Composite samples were secured. The moisture percentages given below represent the losses on heating at 100° C. for eight hours in an oven.

Fallowed land: moisture content ..	..	38·2 per cent.
Cropped land: moisture content ..	..	11·0 per cent.

The figures do not convey as much as may be seen in the handling of the soil. That from the fallowed land kneaded easily, and had the appearance of wet soil. On the other hand, the soil from the cropped land was in the form of hard, dry lumps, difficult to break. The fallowed land was moist at a depth of three feet. 1·5 inches of rain fell at the close of July, and a succession of light falls, totalling 0·70 inch, were measured in early September. These additions of moisture, prior to the sampling, should emphasize the conservation displayed in the fallowed block.

The Lebombo Flats area (23 miles from Magut) has been briefly described in the previous Report. The area records a lower rainfall than Magut. Opportunity was taken of a recent visit to Swaziland to sample experimental fallowed and cropped fields on an estate situated on the Swaziland Lebombo Flats. Twelve samples were secured with the aid of Mr. D. MacDonald, the newly-appointed Cotton Officer in Swaziland. These samples were taken from the top foot, and brought to Magut in containers sealed with paraffin wax. The moisture contents were identical. The failure of the summer rain and higher temperatures have, in this case, not permitted the retention of moisture over the winter.

Black Soil Type.—This is an interesting soil type, forming an appreciable percentage of the land under cultivation. It is regarded as a self-mulching soil. Although the soil is black, the humus content is not high. The nitrogen content is not often above 0·10 per cent. The loss on ignition varies from 5 to 10 per cent., and this includes water of hydration and carbon dioxide. These soils are characterized by a high colloidal content. By Watts' method, the linear shrinkage coefficient from the point of maximum plasticity is 13 in the top soil of cultivated lands, and 14·2 in that of virgin lands. The soil is very sticky when wet. On drying, the surface presents a network of cracks, and small angular particles are formed, hence the term "self-mulching." Immediately below the thin surface layer of small particles are found aggregations of particles, frequently quite large, thus making continuity impossible at the sowing depth of cotton seed. At 5 to 6 inches, in unploughed lands or early ploughed

lands, the soil is moist and free from looseness and excessive air space, even under very dry conditions. Rains of sufficient volume to promote growth in other soils are unavailing on the black lands. With falls of 1 inch and more, the swelling of the soil, and thus contact with the seed, is maintained sufficiently long to permit germination, and the roots may pass into the moist layers below. When conditions have permitted this, the crop progresses in advance of crops on other fields of different soils. Preliminary investigations on the value of soil packing measures, to assist germination under lighter rains, give some promise. The best method of preparing the seed bed is under investigation, and from present observations it would appear inadvisable to plough the land in the season in which it is proposed to plant cotton.

Marchand¹ discussed the origin of the black turf soils of the Transvaal in 1924. The term "turf" is a misnomer. The Transvaal black soil appears to be identical with the black soil in this area. This is the more noticeable, as here also the black soil is frequently bounded by red loam soil as described by Marchand. The mechanical make-up of the two soils is practically identical. The silica-alumina ratio of the red loam soils is, however, quite different from that of the black, the red soil maintaining its fine crumbly structure when wet.

INSECT PESTS.

Some investigations on the control of a cotton seed beetle, *Syagrus rugifrons*, Baly, were reported last year. These were continued. One application of calcium arsenate (5 lbs. per acre) destroyed at least 90 per cent. of the beetles infesting seedling cotton. The dust was applied on a commercial scale by cotton farmers. The local cost of application is 4s. 5½d. per acre at present prices.

Bollworm.—From observations on the system of using trap strips of cotton left over from last year, taken in conjunction with the notes on Time of Planting Experiments and other evidence mentioned below, the trapping method appears to afford a real means of reducing Spiny and Sudan bollworms.

It may be found inadvisable to leave standover as opposed to ratoon cotton as a trap, as it affords a winter breeding ground for stainers, and small numbers of Sudan and Spiny bollworms have been found feeding in the fruit in the winter months. It is advisable, however, to have plants, bearing fruit, on the trapping sites in late August or early September, when observations have shown spring oviposition to be active. Severely pruned plants may be used for

this purpose. Records of July and August rainfall (not depicted in the charts) show that, in most years, winter rainfall may be expected, and fruit would thus result by early September on pruned plants or plants ratooned to 8 to 10 inches in the early winter. At the time of writing (mid-September), trap rows ratooned in June are bearing quantities of young bolls, in which bollworm is accumulating. It is apparently important to have other and later ratooned strips cut well back, which will provide a feeding area when the pruned rows are stripped of their fruit. No actual cutting down or severe cutting back is necessary or desirable, the object being to delay the onset of fresh buds as little as possible. In the season under review, the trap rows produced overlapping fruiting, and a systematic hand stripping of the fruit was employed when the bollworm condition warranted the procedure. On each occasion the plants were badly infested. The stripping was discontinued in late December (four strippings had been carried out from mid-September to the third week in December). The plots were allowed to make a crop, and a small number of bolls opened in May and June. These trap rows were on land next to the Experiment Station, and quite a small area was treated. The large cotton lands surrounding the patch were late in germinating, and experienced very difficult growing weather, so that, from all points of view, it was not expected that the influence of the trap on bollworm population in the neighbouring fields would be felt. A fairly heavy infestation in March was again noted this year. The present evidence points to two main bollworm periods—early spring to December, showing increasing numbers, a lull in January and February, with renewed activity in March and April, which tails off with the ripening of the crop.

The pupation cages designed to determine the course of moth emergence from season to season were not a success. The emergence behaviour requires to be fully investigated, especially in relation to the value of trap crops and crop interchanges. It was clear from sifting the soil in the cages on January 9, that out of several hundred larva-invaded bolls placed therein only forty-eight formed pupæ in cases. Of these the observed emergences were twenty-three from August 26 to January 5. On January 9, the remaining pupæ were classified as follows:

12 appeared to be sound.

2 contained healthy-looking larva.

11 dead; small apertures were seen in the pupal case wall, suggesting
— the emergence of parasites.

These figures are of little value for the purpose sought. Twenty pupæ placed in boxes in the laboratory all gave rise to moths, but in no case did a moth emerge under seven months from the date of collecting the formed pupæ. The conditions being unnatural, laboratory emergence periods are not instructive. Data on long pupation periods under field conditions are required.

Other cages have been prepared. These contain large, deep metal bottoms in the form of boxes, the bottoms of which are perforated to permit moisture movement in the soil. They are set 18 inches deep in the soil. The soil in the metal containers has been sterilized by heat to destroy soil enemies. Large bolls containing larvæ have been collected off plants in the field, and these have been placed over the ordinary soil of the fields in boxes. From time to time the soil in these boxes has been sifted, and the pupæ transferred to the cages. The experiment will be continuous over a long period, and other cages are being erected. Three hundred and seventy-five pupæ have been "planted" in the present cages, and moth emergences have been recorded since May last. It may be stated more clearly that the objects of the cage investigations are to study (1) dates and numbers of emergences (these should afford data on the field observations referred to), (2) long pupation relationships with trapping and other methods for the reduction of bollworms.

A number of cotton growers left trap rows in co-operation with the author. In a few cases these were badly set back by frost. The extent of the trap row area has been considered. If, as seems highly probable, ratooned cotton may be utilized to check insect pests rather than encourage them, under our conditions, there is ample time for large ratooned trap areas to make a crop in the season, given that the plants have been stripped by cattle feeding or by hand at intervals continued as late as the end of December.

It may be of interest here to record the results of what may be termed a trapping experiment over 1,000 acres of ratooned cotton. A grower having resolved to ratoon a large portion of his estate, in the hope of recouping his losses from the poor crop of the previous year, was anxious to employ the entire block as a trap crop, and to utilize large herds of cattle to pasture off the plants when bollworm appeared. This was successfully accomplished over the months of September and October. Fearing that the plants would not recover in time to make their crop, the grower then withdrew his cattle. Flower buds were soon in evidence. These were all shed through bollworm and dry weather. The author could not discover a solitary bud or fruit in any stage in the first week of January. Following

2.25 inches of rain, on February 17, 18, and 19, the plants commenced growing again, and from the lands an average of 400 lbs. of seed cotton per acre was reaped. Every boll set was free of bollworm damage. The plants were small, and bore on the average 6 to 8 bolls per bush, all of which fruited as far as could be judged. The crop was made on 4 inches of rain, most of which was of a soaking character. It would appear that Nature had prolonged the trapping effect to some purpose. The above crop was marketed at grades consistently higher than plant cotton on the same estate. The author holds no brief for ratoon cotton farming, but does not dismiss the possibility of its controlled employment, from the pest point of view, under South African conditions. For the season 1927-28, circumstances are such that the great bulk of the crop in the Magut district will be ratooned, and it is hoped full opportunity will be taken by the growers to utilize their crops as bollworm reducers. It is not improbable that the paucity of fruit set last year will have checked the bollworm population.

Rather belated efforts to capture bollworm moths by hand, as suggested by King,² were made last season on the Station plots. These were moderately successful.

Wild Host Plants of the Sudan Bollworm.—The malvaceous plant, reported in this connection in the 1925-26 Report, has been identified at Kew as *Cienfugosia Hildebrandtii*, Garcke. R. C. Wood later found bollworm in the same plant near the Swaziland-Mozambique boundary. The author has observed the plant in abundance in various places. King (*loc. cit.*) mentions a larva feeding in the fruit of a *Thespesia* in Nyasaland, resembling closely the Sudan bollworm, but the moth is unlike it. No moths have emerged from the pupæ of larvæ collected in the capsules of *C. Hildebrandtii*, and although the larva and egg appear to be identical in all respects, there is still an element of doubt to be satisfied by a view of the moth. If it proves to be the larva of *D. castanea*, then it appears from present knowledge that this plant is a main source of primary infestation in new cotton areas.

It may be definitely reported that *Hibiscus calycinus*, Willd., serves as a host plant for *D. castanea*. The moth has been observed ovipositing on the plant, and the larvæ have been found feeding in the capsules. Eggs were found on this plant in 1925. E. M. Keatinge, assistant at this Station, later found moths and eggs on *Hibiscus calycinus*, growing miles away from cotton lands. The plant is not common.

Spiny bollworm was negligible during the season.

Cotton Stainers.—*Dysdercus* spp. again became prominently in evidence in March, and the volume of stained cotton increased with successive pickings. It is probably correct to say that the greater portion of late set bolls (May and June) did not open, owing to internal boll disease. The final small flushes of cotton are not considered worth picking for sale, but it is probable that the elimination of these, and the cleaning up of bits of seed cotton, will become necessary in order to reduce the stainer population. Seed cotton traps may be left in the lands following the St. Vincent practice. Clean bollworm trap rows will not encourage the stainer, but it is suggested that seed cotton pits be left in these rows at intervals, and treated with a blow lamp from time to time. Similar traps during the growing season did not appear to be of much value.

WINDBREAKS.

Clearing of the bush in this area has proceeded without providing windbreaks from the indigenous tree growth, with the result that very large expanses are entirely exposed to frequent and high wind. The effect is that (1) evaporation is greatly increased. (2) Wind erosion of the soil is pronounced. (3) It is not uncommon to find the foliage of seedling cotton lacerated by flying particles of quartz and shale, or "burned." If a field is partly sheltered, a distinct boundary line is apparent between the sheltered and unsheltered crops: the unsheltered portion may be destroyed. (4) The wind seriously impedes work on the lands.

These matters have frequently been discussed with farmers, and the Corporation's Officer has arranged for the introduction of some twenty varieties of seedling trees, which have been recommended for trial by the Natal Forestry Department. These are mainly species of *Eucalyptus*, *Callitris*, *Casuarina*, *Cupressus*, *Melia*, etc. Two kinds are desired: (a) Those which will rapidly reach a size capable of providing shelter; these would form temporary belts covering the slower growth of (b) more or less permanent shelter belts.

A very few years ago the present "Cotton Belt" of Northern Natal and Zululand was an untilled expanse of thorn bush or thinly wooded grasslands. Small successful trials of cotton growing stimulated settlement here, and the extensive areas brought into cultivation during the last few years have been almost entirely planted to cotton. The country is low veld, differing in climate, soils, and vegetation from the older settled farming communities on the

plateaux, and from the southerly coastal sugar cane areas of Natal. The cotton tract is not continuous, and within different portions of it, and over short distances, the environmental features present many highly important changes and agricultural problems.

Experienced stockmen regard the region as excellent cattle country. Tobacco growing has been undertaken, and the belief is held that ultimately profitable mixed farming activities will result with cotton as a major crop.

OTHER CROPS.

Apart from the climatic and pest hazards in this region, a one cropping system may not be continued indefinitely for many reasons which need not be mentioned here. There is an untouched and highly necessary field of investigation into the local values of other crops, whatever be their place in agriculture. In the interest of the permanent place of cotton growing here, a considerable share of the season's work was devoted to the preliminary trial of other crops. That the season provided a very low rainfall was in many respects a valuable aid in these studies.

Green Manures.—Satisfactory results were secured in the growth of a number of suitable green manures, and it is evident that considerable choice may be exercised in the selection of leguminous and non-leguminous crops with varying growth periods. The latter is an important consideration. The records taken on these crops include time and method of sowing, cultural treatment, nodule formation, flowering dates, insect pests and diseases, weight of green manure per acre, etc. Broadcasting was unsatisfactory in every case, except with buckwheat, rape, vetch, and certain smother crops.

Maize.—In the past, Hickory King, a very late variety, has been grown almost exclusively. It is desirable to study the behaviour of other varieties. Attention has been mainly devoted to early maizes, which appear suited to the market, and which fit in with late season rains—*i.e.*, they may be used as catch crops. Good results were secured from sowing maize and beans in (1) alternate rows, and (2) double alternate rows. The acre yield from these was higher than the acre yield from solid stands of maize. The yields in the single alternate row system were twice those of the double alternate row system. The plants in the single row were larger than the double row plants, bore larger cobs better filled out to the tips with larger kernels. The explanation is probably largely found in the greater root room available for the maize and lack of competition between the rooting systems of beans and maize. In a better season

no doubt such benefits would be obscured, but the practice of multiple cropping should reward greater attention.

Bean Crops.—A wide range of beans was grown. These were all remarkable for their progress under the dry conditions. They were planted under both early and late rains. Early plantings, although remaining green and healthy over long, hot, dry periods, did not set pods, despite copious flowering. The February and March-sown bean crops were decidedly better, probably a question of temperature. Disease was a determining factor on the Experiment Station. Elsewhere, on different soils, disease was much less apparent, or absent altogether. All varieties of *P. vulgaris* were badly attacked by *Bacterium phaseoli*, *nematosporae* sp., and *Rhizoctonia*. The C.M.R., or Cantharides beetle, which destroys the flowers, was present in small numbers. It is a determining factor in some places. *Phaseolus acutifolius*, known on local markets as the pearl bean, *Phaseolus mungo*, and soya beans have all done well, especially considering the season. Market reports on samples of these were quite encouraging. *P. mungo* suffered somewhat from a weevil pest.

A commercial variety of soya beans, "Yellow," went down completely to a *Fusarium* wilt disease. The varieties of soya beans bordering it were unaffected. A leaf spot disease, stated by the Division of Botany, Pretoria, to be a bacterial disease probably caused by *Bacterium glycineum*, was common to all the varieties of soya beans. It was not a determining factor last season, and had not been previously reported in the Union. The soya bean trials will be amplified in the coming season, as they seem to promise well as a cash crop.

It is hoped to secure better material for all bean variety tests, and, in fact, for all crops during the coming season. At present efforts are being devoted principally to determining what will grow profitably, and simple trials only are being conducted. Co-operative trials on other soils are a feature of these tests.

Sorghums.—Non-saccharine sorghums have been grown with considerable success in this area for some years. The ability of these to resume growth and crop satisfactorily after long, dry periods is a most valuable characteristic. Improved seed from early and late strains has been secured from the Department of Agriculture. The early strains were of particular interest last season. These may be used as catch crops following maize, or cotton failure due to short summer rains. It is probable that sorghums will occupy a prominent position in the future crop rotations. They suffer mainly from the feeding of birds.

Groundnuts.—A range of oil and food varieties was grown. Seed from an especially large seeded selection was secured from the Department of Agriculture, and this has been multiplied. Small quantities will be given to farmers this season.

Some 250 long tons of groundnuts were purchased in Natal last year for oil extraction purposes by interests established in the Province. Samples of nuts produced on the Experiment Station were analyzed by them with the following results.

<i>Per Cent.</i>	<i>Japanese.</i>	<i>Valencia.</i>	<i>African.</i>	<i>Carolina.</i>	<i>Tennessee.</i>	<i>Spanish.</i>	<i>Virginia.</i>
Oil	47.38	46.10	44.10	44.42	45.94	45.96	44.36
Free fatty acid	0.55	0.46	0.64	0.64	0.64	0.64	0.64
Moisture ..	5.50	5.90	6.45	5.85	5.45	5.45	5.10

The Japanese and Valencia varieties are considered first-class nuts from their oil content. The three lowest would not interest local markets for oil extraction purposes. On the other hand, ordinary market reports regard the majority as being good quality food nuts. The poor season has undoubtedly reduced the oil content, as the ordinary "Natal" or "African" variety is elsewhere sold (on analyses only) with an oil content equal to the Japanese variety, as given above. Analyses from future crops are desirable.

Five varieties grown in a triplicate test yielded between five and six bags of unshelled nuts to the acre, and 640 lbs. of hay. These figures are given as an indication of cropping possibilities in a better year. Spacing and cultural treatment in general will probably repay investigation.

Hay Grasses.—Those grown were not, on the whole, successful. Their value as winter feed was the main consideration, and it is believed that sowing dates should be arranged to take advantage of the late season rains, when lower temperatures prevail. Sudan grass and red manna promise well under rather better rainfall.

Fodder Grasses.—It is evident that maize and saccharine sorghums may be successfully ensiled in pits. F. R. Parnell, Barberton Station, has secured excellent results with pit silage.

Miscellaneous.—Other crops were grown, some of which merit further attention.

Orchard Trees.—Seed of *Aleurites fordii*, the tung nut oil tree of commerce, was secured from the Horticultural Department of the

University of Nanking, China, and from the Union Department of Agriculture.

This tree would appear to be adapted to our climatic conditions and may prove a source of revenue to farmers. It is suited to indifferent soil conditions on otherwise waste slopes. Seed has been distributed to farmers.

The Experimental Station has accepted a small quantity of seed of *Hydnocarpus Wightiana* for growth trial in co-operation with the Research Branch of the Division of Forestry, South Africa. Chaulmoogra oil derived from the fruit of the tree is used in the treatment of leprosy.

TRANSPORT.

The Pongola-Matubatuba Railway Line has been extended to Gollel, a point on the Swaziland Border. In order to do this, the Pongola River has been bridged. A waggon bridge is under construction over the Pongola River at another point. This provides access to ginning facilities at Candover to farmers in the Transvaal Corridor and part of Swaziland. A railway motor bus service is now in operation to Vryheid, an important centre in Natal, seventy-three miles distant from Magut. This carries freight.

TOUR OF SWAZILAND AND SOME COTTON ESTATES IN MOZAMBIQUE.

During the season, the author was afforded a valuable opportunity to inspect some of the cotton-growing country in the above territories.

VISIT OF THE DIRECTOR OF THE CORPORATION.

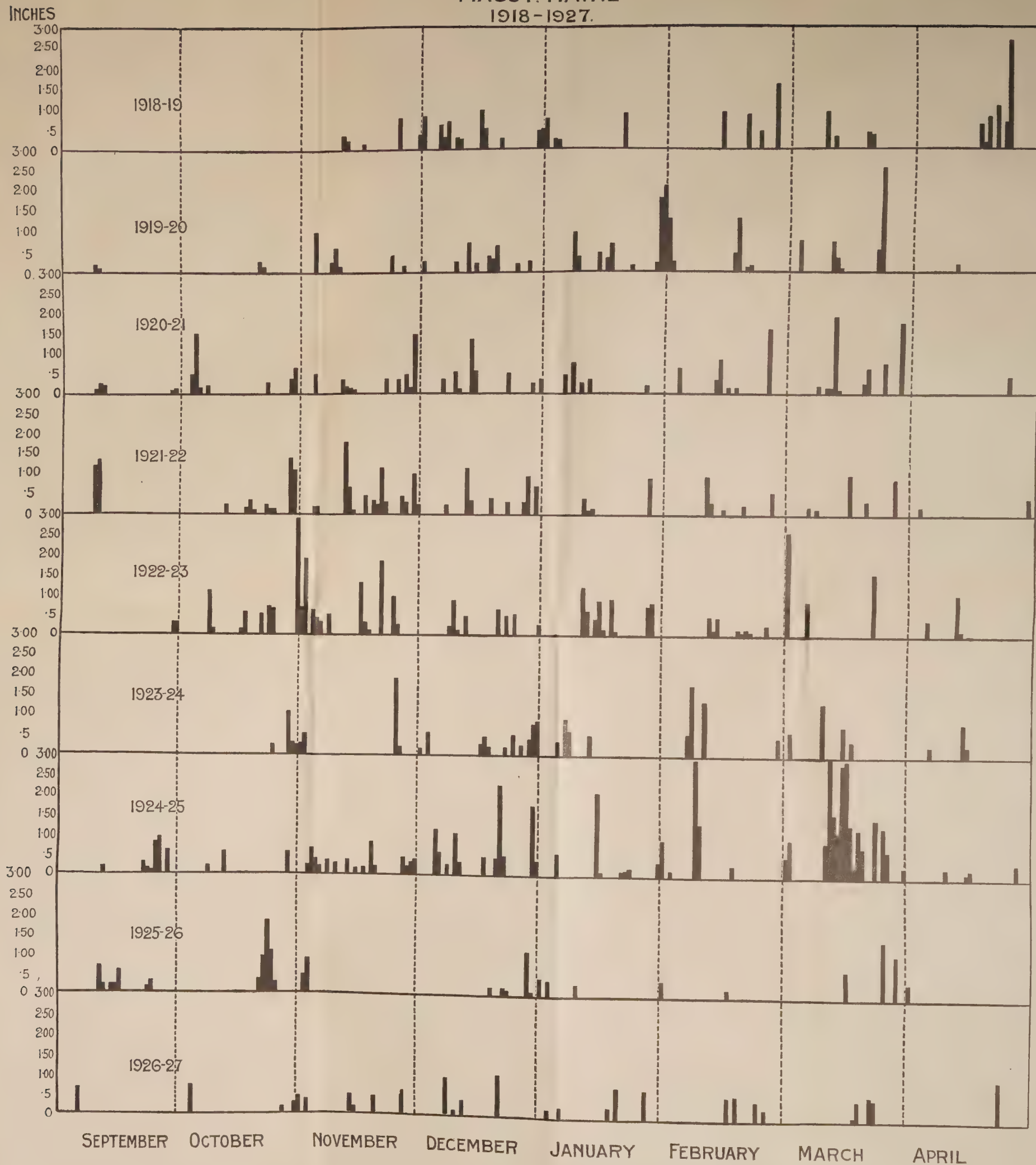
Sir James Currie, Mr. Jefferys, and the Senior Officers of the Corporation in South Africa, visited Magut in May. Cotton farmers were greatly encouraged by the visit.

The author assisted Mr. Parnell at the Cotton Breeding Station, Barberton, during the months of July and August.

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RAINFALL MAGUT. NATAL 1918-1927.



SWAZILAND

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATION, BREMERSDORP, FOR THE SEASON 1926-1927

BY

R. CECIL WOOD.

PROGRAMME.

WORK continued on much the same lines as last year. The experimental programme at Bremersdorp included a continuation of the Time of Planting Experiments, the Spacing Experiments, and the Manurial Experiments on the same land as last year, rented again from Mr. Coates. From the same gentleman, another piece of land was hired, on which the comparison and multiplication of the strains received from Barberton were arranged, while a further piece of unoccupied land in the Township area of Bremersdorp was placed at my disposal by the Swaziland Administration, through the kind offices of Mr. Williams, the Resident Justice of the Peace, and on this room was found for the progeny rows of the Bremersdorp selections made in the previous season.

With the exception of the last-named, this programme was duplicated on land placed at my disposal by Messrs. Cotton Plantations, Ltd., on their Ingwavuma Estate, where a small combined storeroom and laboratory was erected for my use. At both places small plots of other crops which seemed likely to be useful for rotating with cotton were grown for observation; a rather larger trial of five of the more likely of these was conducted at Ingwavuma at the request of the Company.

Arrangements were also made for the further multiplication of three of the most promising of the Barberton strains. Under the section dealing with insect pests will be found the account of an experiment initiated in the White Umbeluzi area, to test the effect of some anti-pest measures.

A successful demonstration was held on the experimental plots at headquarters on March 23, which, in the absence on leave of His Honour the Resident Commissioner, was attended by the Government Secretary, Mr. Nicholson, and a large gathering of farmers and others interested. The Barberton selections aroused considerable

interest, and formed a striking object-lesson of the command which the Plant Breeder has over his material.

SEASON.—For the second year in succession the season has been a dry one for most areas; as seems to be characteristic of the country, the distribution of the rainfall was extremely local. While one farmer would receive none, frequently his nearest neighbour would receive a fall sufficient for the current needs of his crop. The rainfall recorded at Bremersdorp, and at headquarters on the Ingwavuma Estate, will be found at the end of this Report.

The early September rains were ample, and practically universal, and, after three completely dry months, were most welcome, as they greatly facilitated cultural operations. After this the season was disappointing; October was dry, and though some sowing was done in November, it was not until just before Christmas that the planting programme could be completed. The early progress of the crop in these conditions was very slow, and prospects did not seem at all encouraging until the rains in February. From this date, Bremersdorp did not do so badly, and the crop went ahead, with the result that the late crop in this area has been quite a heavy one, especially where jassid was absent (in no area was it severe this year), or where the jassid-resistant strains were in cultivation. Ingwavuma was less fortunate: it did not get the heavy fall of February 1, nor were the March rains so heavy as at Bremersdorp, and in the Lebombo area the crop has for the most part been very disappointing. Actually, the Ingwavuma Estate, which has averaged all over some 280 lbs. of seed cotton to the acre, has been comparatively lucky; its neighbour immediately to the north got no crop at all, while across the river the rainfall was progressively less as one went southwards.

An unusually cold and early spell was experienced in the beginning of May, which gave a minimum on the screen at Bremersdorp of 35° F. In the lowlands a severe frost was experienced, which killed off the cotton completely. The multiplication plots on the land owned by the Swaziland Corporation Development Company suffered in this way, and their yield was undoubtedly reduced considerably.

A meteorological outfit, consisting of the usual thermometers, a rain-gauge, sunshine recorder, and automatic thermo-hygrograph, was received during the year, but though a start has been made in training a native recorder, the instruments are not yet installed in standard conditions.

TIME OF PLANTING EXPERIMENTS.

(a) BREMERSDORP.—This experiment was conducted on the same area and on exactly the same lines as in the previous year, except that the first planting was rather earlier. There were six plantings, roughly at intervals of a fortnight; the plots were one-twentieth of an acre in extent, and were replicated four times. The total yields are as follows:

<i>Date of Planting</i>			<i>Series 1.</i>	<i>Series 2.</i>	<i>Series 3.</i>	<i>Series 4.</i>	<i>Series 5.</i>	<i>Series 6.</i>
			<i>Oct. 4.</i>	<i>Oct. 18.</i>	<i>Nov. 5.</i>	<i>Nov. 22.</i>	<i>Dec. 6.</i>	<i>Dec. 22.</i>
			Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.	Lbs. Oz.
Plot A	..	..	3 15	8 7	10 2	9 15	8 7	9 12
„ B	..	..	11 0	12 4	15 12	17 1	3 1	2 4
„ C	..	..	11 7	15 0	11 0	7 3	8 3	4 13
„ D	..	..	5 1	5 13	7 4	8 5	7 5	7 7
Mean ..	..	..	7 14	10 6	11 0	10 10	6 12	6 1
Per acre	..	..	157 0	207 0	220 0	212 0	135 0	121 0

The variety used was Improved Bancroft, and the seeds were sown by hand in continuous furrows, and were subsequently thinned to about 12 inches. The yields, it will be seen, are in all cases small, and the crop suffered from shortage of moisture throughout its growth. Series 1 and 2 germinated together at the end of October; series 3, after the rains of mid-November. Series 4 germinated at once; series 5 also germinated quickly, but rather uncertainly, while series 6 got the benefit of the soaking rain of December 21, and germinated quickly and strongly. The same unevenness of soil as last year was apparent, and is reflected in the yields given above. As far as can be judged from crop notes taken during the period of growth, series 1 has suffered most from its particular choice of plots, and is relatively better than its yield indicates. Series 4 and 5 never had a full plant, but have probably not suffered from this fact.

Series 1 and 2 may be considered together. Germinating at the end of October, they had a very dry period to face in their early growth; from the middle of November to nearly the end of December only half an inch of useful rainfall was received, and flower buds were forming before the latter date, when the plants were only 6 to 8 inches in height. At this date (December 17) series 3 appeared fair, in spite of the heat and the drought. This state of things continued. Series 1 and 2 never got over their early set-back, and remained

stunted and dried up to the end. Series 3 was more luxuriant, but did not last out, and was ultimately little better in point of yield. Series 4, though it germinated quickly, did not germinate fully, and was full of gaps; in February it was noted as looking fairly well, and likely to give a bigger crop than any of the previously sown series. The last two plantings, series 5 and 6, were also full of blanks, but they grew well, up to a point, and at one time seemed likely to give a good crop. They benefited by the good rains of the latter half of February, but late in March it was noticed that the jassid was likely to spoil their chances, and this was the case, for the pest increased steadily, though slowly, from about this date.

A collection of fallen squares and bolls was made on February 22, in the first three series, which was counted and examined. No difference was observed in the numbers from the different plots; further details of the number of bollworms found and destroyed will be found elsewhere (p. 99).

Flower counts were made twice weekly in two lines in each plot, from February 1, at which date the first four series were producing flowers. Series 5 began on February 18, and series 6 on February 25. The curves, which are remarkably uniform, show a marked rise, after the rain of February 24-28, from March 1 up to March 15. Production then dropped to a minimum on March 22, but again rose, presumably as a result of the fall received on March 18, up to its maximum during the first week in April, after which flower production gradually declined to its cessation by the beginning of May. During this second flush, the last sown plots, series 5 and 6, produced the most flowers; series 1 was the lowest all through.

(b) INGWAVUMA.—The experiment was carried out in exactly the same way as described above, but, owing to a mistake in laying out the plots, the "scatter" was not so good. The full results are as follows:

Date of Planting			Series 1.		Series 2.		Series 3.		Series 4.		Series 5.		Series 6.	
			Oct. 7.		Oct. 21.		Nov. 8.		Nov. 21.		Dec. 7.		Dec. 22.	
			Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.
Plot A	..	..	6	11	3	14	2	12	1	4	3	11	0	4
„ B	..	..	3	4	4	0	5	5	2	2	3	13	0	9
„ C	..	..	5	7	3	1	1	12	3	5	2	2	1	4
„ D	..	..	4	1	5	14	2	10	1	4	1	9	0	8
Mean ..	..	..	4	14	4	3	3	2	2	0	2	13	0	10
Per acre	..	..	97	0	84	0	62	0	40	0	56	0	12	0

The experiment, as will be seen from these figures, was almost a complete failure, owing to the dry weather. The plots were sown in good order, germinated to good stands, and appeared reasonably uniform. Series 1 and 2, as at Bremersdorp, germinated together on November 5; series 3 on November 19. Series 4 and 5 may be taken together, as they both sprouted together on December 25. Series 6 never germinated satisfactorily, and may be disregarded. Notes taken during the growth of the crop repeat the expression "Crop at a standstill," and it can only be said that the season was altogether too dry for the crop to grow. No conclusions can, therefore, be drawn from this experiment as to the best time for planting in this area.

Experiments dealing with the question of the best time to plant cotton have been now continued for two years, and it may be of interest to see what can be learnt from them. Unfortunately, both seasons have been unusually dry, the latter more particularly so, with the result that the dates of sowing do not correspond with the dates of germination, while in all cases, although the plots were laid out in quadruplicate, the results are not sufficiently close to be reliable. There are two questions to which the farmer requires a reply. The first: Is it a sound thing to plant as early as the rains will permit, or is it better, if they are received unusually early, to wait, and perhaps risk not getting good sowing rains subsequently? The second point on which he wants information is, how late it is worth while sowing—*i.e.*, up to what date may he reasonably expect a return for his money?

As regards the first question, there is no evidence from the results of the experiments recorded in last year's report, or in those conducted this year, that any of the plots were planted too early. It must be remembered, however, that last year the first plots were not planted, in most cases, till November, and this year only from the first week in October. Instances in each season have been noted of much earlier sowings—in September last year, and even in late August this year—in both cases the crops failed. A large area in South Swaziland, sown in 1926 with the early September rains, made fair growth, but was destroyed, it was reported, by jassid. There is another aspect of early planting which indicates the need for careful consideration of the whole question, and that is the way in which it affects the red bollworm. After the September rains referred to there was a heavy emergence of moths, and eggs were found, literally, on almost every standover plant of cotton examined. Further, the longer the period between one crop and the next, the greater the chance of avoiding insect damage, not only from bollworm, but from stainers, so

that farmers will be well advised to regard October as the earliest month in which to put in their cotton.

The other question is easier to answer: in no case has cotton planted after the turn of the year shown anything like a return. Earlier than this, the answer is uncertain; at the Red Tiger Cattle Station last year, plots which started to germinate on December 3 proved a complete failure, mainly on account of the bollworm, which was exceptionally bad in this area, while quite close, at Natalia Ranch headquarters, a crop germinating on December 28 gave a comparatively fair return.

The ideal time for cotton to ripen is in the dry weather, which may be expected from mid-April onwards, when dry sunny days and dewy nights facilitate the bursting of the bolls, and make the cotton easy to pick. In the case of jassid-resistant cottons, which, it is hoped, will be universal in the district in a few years, the ripening period is considerably prolonged; this year in Bremersdorp, pickings of upwards of 200 lbs. per acre were gathered in late June. Frost as a termination of the season need not usually be considered.

MANURIAL EXPERIMENTS.

(a) BREMERSDORP.—This is a continuation of the experiment started last year, and occupied the same plots, each plot being one-twentieth of an acre in extent, and being replicated four times. No further manure was applied, as the original dressing of 2,000 lbs. of sifted kraal manure had given negative results. The plots were planted 22 yards by 14 yards, but an outer strip of 1 yard all round was removed before picking started. The results are given in the table below, in which last year's figures are incorporated for comparison.

		<i>Yields (Unmanured).</i>				<i>Yields (Manured).</i>	
		1925-26.	1926-27.			1925-26.	1926-27.
		Lbs.	Lbs.			Lbs.	Lbs.
Plot 1A	..	520	281	Plot 1B	..	337	330
" 2A	..	650	396	" 2B	..	402	335
" 3A	..	405	252	" 3B	..	497	420
" 4A	..	400	315	" 4B	..	320	236
Mean	..	494	311	Mean..	..	389	330

The plots were sown on November 15, and germinated rather weakly. Plot 4B was noted as gappy throughout. The corner

plot, 1B, is on thinner soil, and last year pulled the average of the manured plots down considerably. Making allowances for these two plots, it can be stated definitely that the manure has begun to make itself felt, and has converted the natural inferiority of the plots into a superiority, entailing a relative improvement of something of the nature of 100 lbs. of seed cotton per acre. The evidence is too slight to be completely reliable, but it would indicate that the application of kraal manure may prove a profitable step; and it is desirable to continue the experiment in order to assess how long its effect will be felt.

(b) INGWAVUMA.—This was an eight plot test, arranged to estimate the value of superphosphate on the darker soils of the Lebombo Flats. A considerable amount of money has been expended in the past in this country on the purchase of phosphatic manures, and it seemed desirable to obtain some reliable information on the point. An experiment conducted last year at Natalia Ranch Headquarters gave negative results, owing, it was assumed, to the extremely dry season.

Unfortunately, a mistake was made in the layout of the plots, and the manure was applied to the two pairs of outside plots, leaving the four centre contiguous plots untreated; pairs of plots, however, as numbered below, are directly comparable.

						<i>Yields.</i>			
						<i>Unmanured.</i>		<i>Manured.</i>	
						Lbs.	Oz.	Lbs.	Oz.
Plot 1	..	..	..	..	..	4	6	2	4
„ 2	..	..	..	..	..	3	2	2	13
„ 3	..	..	..	..	..	4	11	3	3
„ 4	..	..	..	..	..	4	14	3	10
Mean	..	..	..	..	..	4	4	2	15
Per acre	..	..	..	..	..	85	0	58	0

The superiority of the unmanured plots is evident and is somewhat disconcerting, as the plots were noted at intervals as being quite level to the eye. It is possible that the manure has upset the capillary movement of water in the soil, and thus favoured the unmanured plots, but, as will be seen, the yields are all very low, and results on this account are not very reliable. The experiment will be continued.

SPACING EXPERIMENTS.

(a) BREMERSDORP.—As in the previous year, the plots were one-twentieth of an acre in size, were replicated four times, and were planted in rows 1 yard apart. In view of the reasonably definite verdict last year in favour of 12-inch spacing in the rows, as compared with 24 and 36 inches, the spacings adopted this season were closer, and the rows which were sown in a continuous line were thinned out approximately to 6, 12, and 18 inches. Sowing was done on November 16, but the original stand was patchy, and as some time elapsed before filling could be done, and as even then germination was slow and irregular, a considerable time (sixty days) elapsed before thinning was done, and this, as has been shown by Parsons (*EMPIRE COTTON GROWING REVIEW*, vol. iv., No. 4, pp. 344-351) and Wells (Report: "Callide Cotton Research Station, 1926") has probably reduced the advantage which the more widely spaced plants might be expected to possess.

The variety used was Webber 49, and the experiment occupied the same area, though the plots were changed. Actual counts of the plants in average rows show that the actual spacings obtained were 9, 13, and 16·5 inches. The yields are as follows:

<i>Spacing:</i>					6 Ins. (9 Ins.).		12 Ins. (13 Ins.).		18 Ins. (16·5 Ins.).	
					Lbs.	Oz.	Lbs.	Oz.	Lbs.	Oz.
Plot A	..	..	..	..	5	4	5	9	2	15
" B	..	..	..	..	8	11	10	0	9	15
" C	..	..	..	..	10	2	9	5	10	9
" D	..	..	..	..	5	9	2	13	7	12
Mean	..	..	..	..	7	6	6	15	7	13
Per acre	..	..	..	..	147	0	138	0	156	0
Actual space per plant	..	..	..	..	324 sq. ins.		468 sq. ins.		594 sq. ins.	
Yield per plant	..	..	..	..	0·12 ozs.		0·17 ozs.		0·24 ozs.	

The yields are disappointingly low, and the crop suffered from drought through its whole period. Picking started 140 days after sowing and closed 226 days after sowing. Flower counts were made on two lines in each plot, from the 92nd to the 174th day from planting, the maximum flower production being from about the 120th to the 140th day. Production was remarkably similar in all plots, and little difference could be observed.

It is clear that the plants have only just responded to the extra

space allotted them, though it might have been expected in a dry year like this that some extra benefit would have been obtained from a thin stand. The "edge" effect was very marked, however, in all plots, as it was elsewhere, and this would indicate that where the plant has plenty of space *from the start*, it can make use of it, but that late thinning will be of little benefit; the ground, in all probability, remained too hard to permit of much fresh root development in the absence of any good soaking rain. It was noticeable that the growth of the plants in the multiplication area, which were all planted out by hand at 36 by 36 inches, was in all cases excellent, and from these plots good yields were obtained.

(b) INGWAVUMA.—An exactly similar experiment was conducted here, but unfortunately the season has been even more adverse, and yields are too small to be reliable. As mentioned above, thinning which was done about fifty days after planting was evidently too late, and little difference was observable in the response of the crop.

Little further experience has been gained towards solving this problem, and the general conclusions drawn from last year's figures stand good still, that about 1 foot spacing is likely to give the best results in seasons similar to the last. Too early thinning implies some risk of the small plants becoming damaged subsequently, and for this reason the practice will not commend itself to farmers; too late thinning, on the other hand, seems ineffectual in helping the crop through a period of drought.

SELECTION WORK.

Last year's Report gave particulars of the fifteen plants selected for further trial during the current season. These fifteen were all planted out in progeny rows on a piece of sandy land in the Bremersdorp Township, on November 6-9, by hand, one seed being dropped in each hole. The ground was on the dry side, and germination was anything but satisfactory, though it must be remembered that every available seed was planted, and much of it was of only moderate quality. Consequently, none of the plots gave as much as a 10 per cent. stand, with the result that it was difficult in most cases to form any conclusion about the real habit of the plants, which sprawled and straggled excessively. Further, Internal Boll Rot has been extremely severe, and much of the cotton picked is very heavily stained. Selling started at the beginning of February, and a good many flowers were stitched during the season. Jassid appeared early in March, and notes were made of the resistance of the strains to this pest on March 15, March 25, and April 28. Picking started

on March 31. A number of fresh selections were made in all the progeny plots, but the writer's hurried transfer in July made the detailed examination of all of these impossible, and it was decided to proceed with only six, the details of which are as follows:

Number.	Weight of Selfed Seed.		Weight of Unselfed Seed.		1926-27.		1925-26.	
					Percentage of Lint to Seed Cotton.	Length of Combed Lint.	Percentage of Lint to Seed Cotton.	Length of Combed Lint.
	Lbs.	Oz.	Lbs.	Oz.		Mm.		Mm.
8	0	5	3	13	38	24.5	31.4	26
11	0	14	6	6	36	24	31.1	25
14	0	2	2	0	35	23	33.5	27
15	0	3	3	0	35	28	33.0	26
57	1	10	15	4	34	25	30.9	25
63	0	1	17	5	29	25	30.9	27

All were resistant to jassid and have lint of good quality, and it is hoped will afford useful material. With the re-selections mentioned above, all have been handed over to the Corporation's Plant Breeder at the Cotton Breeding Station at Barberton.

CAMBODIA SELECTIONS.

Five single plant selections were received from the Cotton Breeding Station at Barberton, and were planted alongside the Bremersdorp selections referred to above. Although there was only a few days' difference in the date of planting, the Cambodia selections came along well and grew into strong plants, with about a 50 per cent. stand. Later on they developed the usual objectionable straggling habit which characterizes this variety, though not to such a marked degree as in the previous year. C8/19 was noted as being particularly lax, while C8/8 broke so much that it was impossible to see what was its real habit. C8/2 was the best and produced, moreover, the cleanest cotton, the others all suffering more severely from Internal Boll Rot.

The actual yields picked are as follows:

Number.	Yield.	Yield per Line.	
		Lbs.	Oz.
C8/2	28	2	8
C8/6	26	1	7
C8/8	50	1	8
C8/11	33	1	8
C8/19	12	1	0

The plots are reasonably comparable; the yield of C8/2 works out to about 680 lbs. per acre. Quantities of selfed seed of each strain have been returned to the Cotton Breeder, Barberton, as well as a number of fresh selections marked in the field this season.

BARBERTON JASSID-RESISTANT STRAINS.

For the purpose of comparing the value for Swaziland of some of the most promising strains produced by the Corporation's Plant Breeder at the Barberton Station, and at the same time multiplying the seed for such future requirements as might be indicated, two series of plots were arranged, one at headquarters and one at the Ingwavuma substation.

(a) BREMERSDORP.—The plot of land selected was in appearance of less than average fertility, and consisted of rather more than three acres of upland lying on a fairly uniform slope, in general of a sandy nature with numerous stones, and here and there outcrops of more solid stone. The difficulty of obtaining uniform land for experimental work in the middle veld has been mentioned before, and it was found that the higher plots along the upper portion of the field were considerably handicapped. Four standard plots of Z1 bulk scattered about the field gave the following yields:

(a) Lower Row: EAST	580 lbs. per acre.
(b) Lower Row: WEST	560 " "
(c) Middle Row	390 " "
(d) Upper Row	240 " "

The land had previously carried a crop of Teff Grass, which had been grown to stimulate the germination of dormant orobanche (Rooibloem) and ploughed in. Sowing was done by hand on November 18 to 25, two seeds to a hole, the holes being spaced 3 feet by 2 feet.

The strains have all proved most satisfactory, and many of them have given yields which, in the circumstances—the rather poor soil and the very dry season—may be considered excellent. The layout of the plots was of the nature of a compromise, since an accurate comparative test, while affording the information, would not have provided the seed to take advantage of it, while multiplication plots pure and simple would not have afforded any comparison at all between the strains. Thus the figures given on p. 94 are not intended to represent the real comparative cropping capacity of the strains.

Of all the strains B179 appears to win on points, but it is closely followed by Z1 and its re-selections Z1.5, 14, 24, and 25, which are all resistant and all good croppers. The low yields of 14 and 24 are due to their position, as will be seen from the adjacent controls of

Z1. All these Z1 strains are extremely uniform and similar in appearance, with a thrifty, hardy appearance, which unfortunately tends rather to over-production of wood. B179 is a squat, sturdy plant, rather leafy, but vigorous and setting big bolls. B134 has given a heavy yield from a small plot, but it undoubtedly had the benefit of a good patch of soil; it has a nice habit, but is rather lacking in resistance to jassid. B143 has a characteristic grey-green leaf, in which respect Z106 resembles it; it opens its bolls badly, so that it is difficult and expensive to pick. B115 has not done well comparatively, and may be discarded. B181 suffered from rather a poor stand, apparently a characteristic of this strain, which had a large and very fuzzy seed, somewhat difficult to germinate. B180, which was the best at Barberton last year, has not shown up here particularly well; it occupied rather a poor and stony plot, and had a very patchy stand, but it has not cropped well, and suffered from jassid towards the end. B117 has a very leafy habit, and, until the jassid got it, looked most promising. It is the worst for jassid resistance, but even in this case the effect of the pest was not enough to do much serious damage to the crop. B176 is definitely less resistant than B179; it was on poor soil, but grew strongly; it is a good strain, but possibly not quite up to the mark. B144 has not cropped very heavily; it is rather a lax, leafy type.

Name.	Area in Centals.	Yield per Acre.	Resistance 0-5.	
			March 25.	April 19.
LOWER ROW.	Z1.5	610	5	4
	Z1(a)	580	5	3
	B115	360	3	2
	B181	430	4	3
	B143	730	5	2
	B134	840	4	2
	Z1(b)	560	5	3
	Z1.25	630	5	4
	U4	(small)	5	3
MIDDLE ROW.	Z49	290	5	4
	B180	310	5	1
	Z124	260	5	4
	Z1(c)	390	5	3
	B144	380	5	3
	Z152	570	5	4
	Z106	770	5	3
	B179	700	5	4
	B117	300	3	0
UPPER ROW.	Z1.14	240	4	4
	Z1(d)	240	5	4
	B176	300	3	3

Of the new Z selections, Z49 is late, and was not very uniform; it came on towards the end of the season, when it looked well, but it has not cropped very heavily. Z106 is the most distinctive of all the strains; it has the "poplar" habit, tall and cylindrical, with few vegetative branches. It has characteristic greyish-green foliage, and is a heavy cropper, good for jassid-resistance. Unfortunately it opens its bolls badly, and produces too high a proportion of stained lint. Z152 is a tall, leafy, rather open type, resistant to jassid and a fair cropper.

U4 is a characteristic type with a small boll borne in profusion on a number of laterals. It was a very poorly filled plot, and contained a number of types, with some undoubtedly promising material.

From their reputations elsewhere, and their behaviour here, it seemed likely that some of the following would be worth carrying on, and a rough examination of their cotton was made, with the following results. Measurements of combed length were made on seeds taken from near the centre of three clean locks picked at random.

Name.	Length in Mm.				Remarks.
	Single.			Mean.	
Z49	24	25	23	24	A nice type: edge of halo hard; a slightly harsh, bold cotton.
Z106	22	20	23	22	A short, wasty lint.
Z152	28	25	27	26.5	Soft, but fairly strong; twist poor.
B134	22	25	25	24	Very strong, with plenty of twist and good edge; rather harsh.
B143	28	27	27	27.3	Very nice, soft lint; bright with good twist; medium strength.
B176	23	22	25	23.3	Rather mixed and badly stained; lint soft and strength fair.
B179	27	25	24	25.3	Rather irregular; halo thin and cotton weak; too soft.
B180	25	24	24	24.3	Inclined to be harsh; moderate strength.
U4	24	21	26	23.7	Weak; a poor sample; rather diseased.

(b) INGWAVUMA.—The same varieties were grown at the sub-station at Ingwavuma, but unfortunately the plots were sown late, and never grew at all well. A small quantity of seed has been obtained, but the yields were in most cases insignificant. U4 put up a very much better show here than at Bremersdorp, and it is possible that this strain may prove useful to the Lebombo country.

(c) Arrangements were made with three farmers to multiply some Z1 bulk, Z1.5 and Z1.25, the seed of which was supplied from Barberton. The success of these plots has been most striking, and

indicates the future possibilities of the cotton crop in Swaziland under good farming conditions and with good strains of cotton. The cotton was planted out by hand, one seed to a hole, and gave in most cases a reasonably full stand. Mr. P. J. Lewis at Matapa was particularly successful in this respect. The best yields were from Dinedor, in the White Umbelusi district, grown by Mr. G. L. Wallis, who averaged over 500 lbs. for the whole area; the Z1 re-selections, on half an acre each, gave just over and just under 1,000 lbs. of seed cotton per acre—a most satisfactory result; the Z1 bulk plot suffered from a very poor stand. The Swaziland Corporation Development Company averaged less than this, but, as mentioned above, the exceptionally early frost stopped this cotton, and from what was obtained from other crops which had not suffered in this way a very heavy yield might have been obtained (a photograph of this crop in full bearing is attached). At Matapa, Mr. P. J. Lewis, at a higher elevation and on more intractable soil, obtained a yield of slightly over 400 lbs. to the acre.

The seed from these plots will be utilized for general distribution for the coming season, under the name Barberton 1, and will go far, if conditions are favourable, to ensure that the whole of the 1928-29 crop will be planted with this strain.

Other Varieties.—A variety known as Arizona was imported from Rhodesia, where it was reported to be drought-resistant. It was planted out in three plots, but failed to make good, as it proved highly susceptible to jassid. Some of the writer's Mp12 was also continued, but germination was very poor, and the strain is obviously unsuited to the locality. Two Cambodia strains, Nos. 516 and 664, were grown along with the other Barberton selections, both at Bremersdorp and Ingwavuma, but proved to be very late in maturing, and yielded practically nothing.

Rotation Crops.—The season has proved too dry for most of the rotation crops that were tried, especially at the Ingwavuma substation. A number of pulses were grown, but in the Bremersdorp area the C.M.R. beetle, as it is called (various species of Meloid or Blister Beetles), almost entirely precludes the production of grain. Enormous numbers were hand-picked, which is the only method suggested at present for dealing with the pest. Soy beans are a likely crop, and local seed was grown alongside purchased varieties both at Bremersdorp and Ingwavuma. At the latter place the local seed gave the better crop; at Bremersdorp the black variety yielded a reasonable return; the crop is a valuable one, and in normal circumstances should do well and form



NO 1. PROGENY ROWS: BREMERSDORP SELECTIONS, 1926-27



NO. 2. Z 1.25 AT MESSRS. SWAZILAND CORPORATION DEVELOPMENT COMPANY

a valuable rotation crop for cotton. Brabham cowpeas, the only variety tried, showed their suitability for either green manuring or grain production. *Ph. mungo*, the "mung" bean, grew well, but was blotted out by the C.M.R. beetle. Florida Velvet Bean (*Stizolobium*) and Sword Bean (*Canavallia*) both stood up to the drought well, but it is doubtful if they can be grown profitably for seed, as they are not at present in export demand.* Greater possibility attaches itself to the prospects of the Groundnut (*Arachis hypogea*) and the Bambarra Groundnut (*Voilandria subterranea*), both of which are already known in this country. The local demand for groundnuts appears to be increasing, as the mines are making increasing use of them in their rations, while there is a steady export demand for the better qualities. The variety mostly grown is a cluster type, which can be easily lifted, but further investigation into other suitable varieties is most desirable. Five named varieties imported from India were tried this year on two different classes of soil, but the season was very much against them. On a red diorite soil they yielded practically nothing; in the sandy soil, alongside the Bremersdorp selections, they did a little better, and produced enough seed to carry on next year. Small Japanese and Spanish No. 10 are cluster varieties, and need earthing up; Transvaal, Carolina, and Mauritius are the ordinary spreading varieties, which probably yield more than the cluster ones, but at a greater cost. Similar to these last was a local variety obtained from Balagana in Northern Swaziland; its origin is not known, but it showed up the best of all. The Bambarra nut, which is locally called Hluba, and which is known in the trade as the Jugo bean, has shown its value in this dry season, and at Ingwavuma yielded just 500 lbs. an acre on a two-acre plot, which, considering the season, is excellent. On the red soil at Bremersdorp it failed completely.

Oilseeds offer hopes of a rotation crop, but the most likely, Simsim (*Sesamum indicum*), has not, up to the present, shown very much promise. Last year it was fair, but this year the drought was altogether too much for it, and with the exception of a small plot on the light soil at Bremersdorp, it failed completely. Niger (*Guizotia abyssinica*) again did well on all three plots, and if a market could be found for this, it might be a profitable crop to grow. Sunflower was grown, but did not crop heavily enough. Safflower (*Carthamus tinctorius*) was not successful; the poor seed obtained last year was planted this year, but failed to give a crop.

* H. C. Sampson, "Report on Rotation Crops for Cotton," *Empire Cotton Growing Corporation*.

There remain the millets. It is probable that a great portion of the cotton-growing country on the flats is too hot and too dry for maize, though little appears to have been done in trying varieties more suitable than the ordinary high or middle veld ones. A two-acre plot gave practically no yield this year at Ingwavuma. For these areas millet should be suitable, and *Sorghum vulgare* is already grown. The variety is a good one, short strawed (straw has no value at present), with long narrow medium compact heads, and (usually) red grain. A two-acre plot of this was planted at Ingwavuma, and gave only a poor yield; the ears set, but did not fill out properly, while stray cattle did a good deal of damage. There have been some fine crops grown in other cotton-growing parts of the country, though in two cases that came to the writer's notice expectations were dashed right at the end of the season by a severe attack of aphis, which simply scorched up the crop, dried the grains, and caused the crop to fall over at the first breeze in inextricable confusion. A white variety, similar in other respects to the above, was noted as doing well in a very dry area in Portuguese East Africa. Another millet, which is already grown in Swaziland, but on a small scale, is the Bulrush Millet (*Pennisetum typhoideum*).* Two plots, one in the red soil and one in the sandy soil, were planted with selected seed obtained from Nyasaland, and both, in spite of poor germination, yielded remarkably well. There seems to be a great future before this grain, if the experiments now being carried out at Cambridge corroborate its feeding value, and improve its price on the market. Other millets which are possibly worth trying are Finger Millet (*Eleusine*), which is occasionally seen in this country, *Setaria Italica*, and some of the *Panicums*, but it is probable that their market is a limited one.

Other crops which were tried may be briefly dismissed. Mustard (from India) has failed both years. Corianda failed the first year, and unfortunately was not tried the second year; a Dolichos bean, obtained from Kenya under the name of Njari, was grown, but though it formed a luxuriant cover crop, it failed to set seed, owing to its lateness and the attacks of the C.M.R. beetle. Lucerne (Provence) stood the drought wonderfully, but of course gave no weight of green leaf as a dry crop. Linseed grown for seed failed; it was sown too thick, and was not properly thinned, so that it never had a real chance. Sunnhemp has ripened a fair crop of seed each season, and in every plot, in a rather unexpected way; as a green manure it seems to possess possibilities, but it needs a heavy seed rate, which would

* See H. C. Sampson, *loc. cit.*

make it costly. *Trifolium Johnstoni* and *Astragalus venosus*, both from Nairobi, failed.

Recapitulating, then, the crops that seem to offer most prospect of success and most need investigation are Bulrush Millet, Ground-nuts, Hluba Beans, Soy beans, and Sesamum.

INSECT NOTES.

The dry season has probably been the reason for the comparative immunity of the cotton crop from insect pests during the year under report.

Jassid (Empoasca fascialis).—The appearance of this pest was first noted as early as January 18, but it did not begin to appear in numbers until the middle of February, when its effects on the plant became visible; both fliers and nymphs were then common. It progressed very slowly from then on through March; it was noted on April 5 that the pest was not increasing to any extent. Of all the varieties and strains grown, Arizona, imported from Rhodesia, suffered the worst, and its yield was seriously reduced thereby. Improved Bancroft and Webber 49, on the experimental plots, were not so bad, though they definitely suffered from the pest. The jassid-resistant strains from Barberton were very slightly affected, and in consequence were able to continue producing cotton till late in the season; a last picking of upwards of 200 lbs. per acre was obtained at the end of June. Of the Bremersdorp selections some showed complete resistance, others were markedly susceptible, and have been rejected on this account.

Red Bollworm (Diparopsis castanea).—Further observations were made on its life-history. After the heavy rains of early September, the eggs of this moth were found almost universally on all stray cotton plants that were examined; moths were found on September 27, and young larvæ in October. Eggs were found on the earliest Time of Planting Plots on December 1; on the 20th, a dissection of twenty-four buds, picked more or less at random, showed 75 per cent. attacked; in more than half of these the grub was actually found. The grub was found plentifully from then onwards in the buds and squares of all the crops examined, and growers were recommended to pick the flared squares, a job which it was found easy to teach native children. On January 19, 620 squares were collected in the Time of Planting Plots, of which over half had living worms inside. On February 22 a collection of all affected squares and bolls, whether on the plant or on the ground, was made off a number of plots in the Time of Planting Experiment. The average off 12 plots

gave a figure of about 200 fruits to the plot. In samples of these, 25 per cent. of worms were actually found and destroyed, so that the result implied the extermination of some 1,000 worms to the acre at this comparatively early stage. At the same time, mixed samples of twenty-five shed squares and bolls from each of the spacing plots gave 20 to 28 per cent. actually containing larvæ, of which 8 per cent. were Spiny Bollworm. Various other counts were made which corroborate the above, and show that the early attack of bollworm is a heavy one. It has been suggested that considerable relief could be obtained later in the life of the crop if this early brood could be destroyed, and accordingly a good deal of handpicking was done, and recommended to others.

Note may be made here of a combined experiment which is being carried out on a few farms situated in a compact group on the White Umbelusi, and separated rather definitely from any other cotton-growing area. It was considered that this was an exceptionally suitable area in which to test the efficiency of such anti-bollworm measures as could at present be recommended. A meeting of the farmers concerned was held on January 22, and all agreed to arrange to pick off all flared squares from the standing crop. It was found necessary to do this two and three times during the growth of the crop, and enormous numbers of the larvæ must have been destroyed in this way. It is worth noting that the heaviest crops in the country were harvested in this area; one grower, with two half-acre plots of a jassid-resistant cotton which he was multiplying under agreement with the Corporation, picked over 1,000 lbs. to the acre. It is, of course, impossible to attribute this to the particular operation noted above, but arrangements have been made, with the permission of the Administration, to leave three small fields of cotton over as trap crops in the coming season, and the progress of this experiment is likely to be interesting.

To return to the progress of the pest. A moth was seen on November 24, but was not captured. On January 31, two were found on sunflower plants, alongside cotton in the Town Field; these were presumably the new season's brood. In one or two cases the grub was found feeding in young soft stems and petioles, though bolls were available. As reported last year, a number of affected bolls were placed in tins over some soil on June 15 and 29, 1926. By July 12, no moths had emerged, and the bolls were, therefore, removed, the soil sifted and replaced in the tins, which were again placed in the open. On January 25, 1927, one of the tins was turned out, and about a dozen pupæ were sorted out; up to this time no moths had

emerged. These pupa cases were transferred to a glass jar with a gauze lid, and on February 19, it was found that a moth had emerged and had laid eggs all over the inside of the jar, and on the other pupa cases therein. Two others emerged within a fortnight; evidently the transference from the earth of the tin to the glass jar had in some way stimulated emergence.

A discovery of considerable interest was that a widely distributed wild plant, *Cienfugosia Hildebrandtii*, Garcke, must be regarded with considerable suspicion as a host plant of this pest. On March 2, 1927, what appeared to be Red Bollworms were found in numbers on this plant, which was growing profusely in a dry stream bed on the Changalane Estate. The plant has been identified as above; it has been seen commonly in the low country, and has also been reported by Parsons from North Zululand. A moth, which to the writer's eye was undoubtedly *Diparopsis*, was seen at the time, but could not be caught, and identification by larvæ is not definite, but it is hoped to hatch out some pupæ, and place the identification of this pest beyond doubt. The question, it is understood, has been settled as far as North Zululand is concerned. It is, of course, well known that the common wild cotton (prob. *obtusifolium*)* harbours this pest. On February 24, eggs and nearly mature larvæ were found in a plant close to the experimental plots in Ingwavuma.

Later in the season the pest seemed to disappear, and little damage to the late crop has been observed. At the time of writing, in July, bolls have all opened and dried, and eggs cannot be found. With regard to the future, it does not seem likely that, with the large reservoirs of re-infection existing in the wild cotton and the *Cienfugosia* mentioned above, the pest will ever be completely exterminated so long as these exist. There are areas, however, such as the White Umbelusi group of farms mentioned above, where these plants do not exist, the country being mostly open rolling veld, and here careful control measures should be completely successful. In the low country the pest has not yet become very serious, possibly because the rate of expansion, in the case of the large companies, has been so rapid, but the pest may be expected. It is in the case of these large companies, however, that properly managed trap plots can best be organized and supervised, and this measure, coupled with the destruction of the early infection, should keep the pest within reasonable limits.

Stainers (*Dysdercus* sp.) and *Cotton Seed Bugs* (*Oxycarenus* sp.) have been responsible for a great deal of damage during the season,

* Baron Surcouf, of the Mozambique Company's Territory, reports a wild cotton under the name of *G. anomalum*, Agr. Conference, Nairobi, August, 1926.

if it is accepted that they are the cause of Internal Boll Rot. Some of the plots suffered so badly from this disease that it was difficult to find a healthy boll, and the total loss to the crop from the depreciated value of stained cotton must have been considerable. The first Red Stainer was seen on January 22; adults were seen coupled at the end of February, and on March 7 young ones were seen for the first time. They were reputed plentiful towards the end of March, but do not seem to have increased very rapidly after that. They were found in the largest numbers in the progeny rows, where, owing to the wide spacing, the plants had developed a large and sprawling habit, and their lower branches, lying on the ground, collected the fallen leaves and trash, and here the stainers could be found in numbers. Reports are received from time to time that they are breeding in non-malvaceous trees, but these have not been verified; they will swarm on anything, but do not feed. An immense number were seen in July last year around a compost pit which was being filled with cotton seed (meal); they must have come from far afield, attracted by the slightly fermenting seed.

Little is known of the importance or otherwise of the Cotton-Seed Bug (*Oxycarenus*). Complaints have been received of the irritation caused to the hands of the pickers when this pest is present in large numbers, and it imparts a most unpleasant smell to the cotton. It has been found swarming in the empty fruits of Cienfugosia, which had been gutted by the bollworm.

Weevils.—Early in January a report, with specimens, was received from a farmer in the Bremersdorp area of damage caused by a weevil. The damage was difficult to assess, and did not seem to be very serious, but as the very idea of a weevil on cotton is disconcerting, specimens were sent to the Union Division of Entomology. Most of the specimens were identified as ground weevils, apparently of two new species, but there was also a specimen of *Apion*, a genus which is known to be a somewhat serious pest of cotton in East Africa. The weevils disappeared in a short time.

Syagrus rugifrons was found in the larval stage, attacking fairly large plants (early March) in the White Umbelusi area, and causing their death by ringing the tap root. This is the only occurrence noted of this pest, which is reputed as doing some damage in the Magut area.

Meloid Beetles.—Reference has been made above (p. 96) to the attacks of Meloid beetles, which are of importance in that they almost preclude the cultivation of certain pulses in some areas; in any case they increase the difficulty of growing seed to be used for producing green manure crops. An inquiry was made to the Entomological

Section of the Agricultural Research Institute, Pusa, as to the results of the investigation which had been made into the possible commercial value of these beetles, which, it was understood, had been initiated by Maxwell Lefroy. The reply was to the effect that there was a possibility of both a local as well as an overseas demand. The matter is worth further investigation.

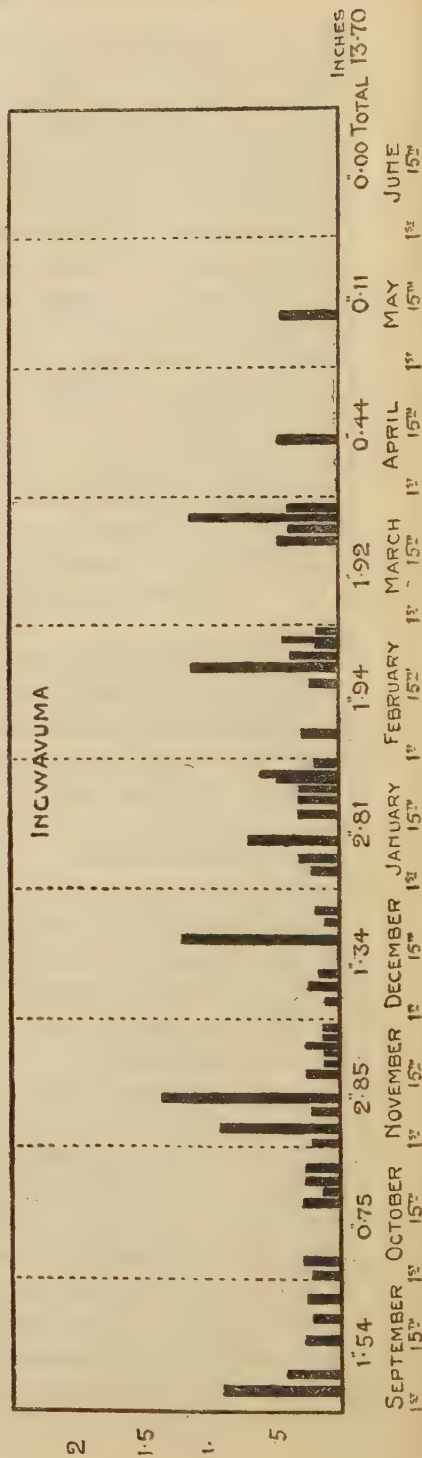
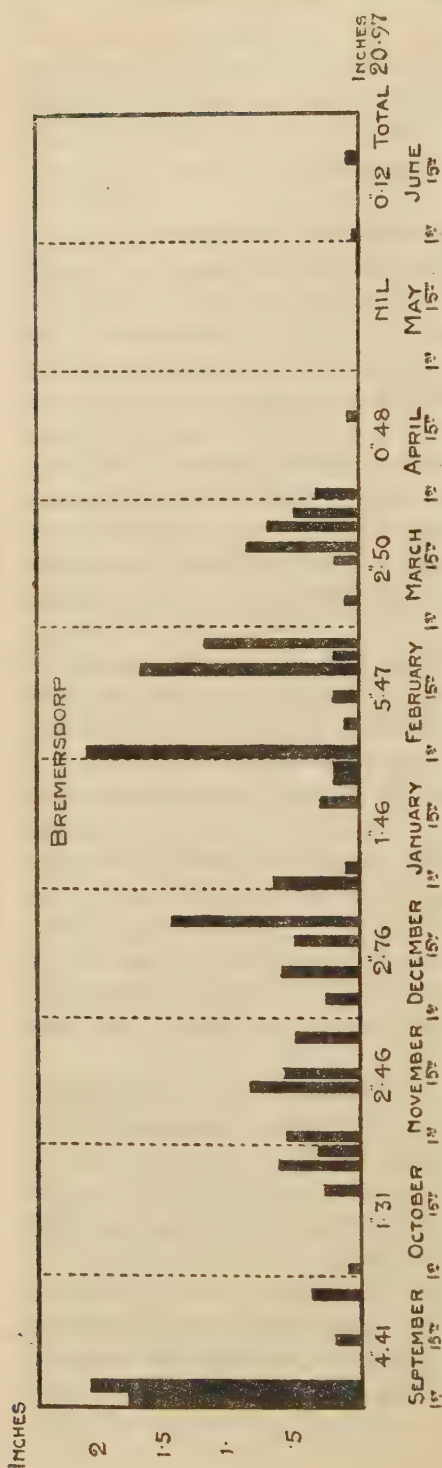
Miscellaneous.—The dry season and the consequent shortage of natural grazing has again emphasized the desirability of supplementing what grass the cattle can pick up with some artificial food, and for this purpose cotton-seed is excellent. Reports as to the difficulty of persuading animals to take to it invariably turn out to be exaggerated, and as the area of land under the plough becomes more concentrated, as it is already becoming on some of the larger estates, the necessity for artificial feeding will increase. Even with good grazing it is questionable whether the time and energy necessary for a bullock to pick up its own food does not prevent it from putting in the full quantity or quality of work that should be expected of it. The use of cotton-seed meal directly for manure is not on the increase.

A simple germination test of some seed which had been treated with sulphuric acid was done, and showed the extremely satisfactory quality of the seed, 85 per cent. of which was through in a few days in the test. It was of the Uganda variety, and had been taken from a consignment that was treated by Messrs. Kynochs for use by Messrs. Cotton Plantations, Ltd., at a cost of 1d. a lb. on weight of seed before treatment. Actually, much of this seed lay dormant in the ground for a period of from three to six weeks after sowing, so that there was no doubt of its vitality. The seed is easy to sow, and germinates, in favourable conditions, quickly and evenly; a rate of 17 lbs. to the acre through the planter gave a full stand, and the stand was reported by the Manager to be better than when using untreated seed.

Among implements found useful mention may be made of the "Norcross" line of cultivator hoes, which are admirable for the scuffling of small plots which cannot be bullock-hoed. They are manufactured by C. S. Norcross and Sons, Illinois, U.S.A., and are fitted with renewable tines. Nothing further was heard of the cotton stalk puller referred to in my last report.

At the request of the Division of Botany in the Union, periodical reports of the incidence of fungous diseases were made, but a mild attack of Black Arm (Bacterial Blight) was all that merited mention. It appeared only on the leaves, and has not been noticed on the bolls.

SWAZILAND. SEASONAL RAINFALL, 1925-26.



SOUTHERN RHODESIA

REPORT ON THE WORK OF THE COTTON- BREEDING STATION, GATOOMA, FOR THE SEASON 1926-1927

INTRODUCTORY NOTE BY THE HON. J. W. DOWNIE,

Minister of Agriculture and Lands.

I GLADLY respond to Mr. Cameron's invitation to write a foreword to the Annual Report on the work of the Cotton-Breeding Station, Gatooma, for the 1926-27 season.

The Government of Southern Rhodesia, and farmers in all parts of the Colony, are alive to the need for good seed, and fully appreciate the importance of the work being performed by the staff of the Empire Cotton Growing Corporation at Gatooma, and not only at Gatooma, but throughout the Colony.

Cotton, as a "Planters'" crop, had a serious set-back three years ago, due to pests rather than to prices. There is no doubt that it will take its rightful place in diversified farming once those engaged in the task have evolved a type of seed suited to our climatic conditions, and able to resist the ravages of the pests with which the plant—and the grower—is affected. That the staff of the Empire Cotton Growing Corporation will breed up such seed I have no doubt.

Rhodesian farmers are nothing if not optimistic, and despite the disappointing results of the last three years, the officials have had to restrain rather than stimulate the growers' interest in the crop.

Given time and encouragement to continue their investigations, all the meticulous, detailed work which is being undertaken with a patience and perseverance worthy of the highest traditions of scientific research, the officials at Gatooma will enable those interested in establishing cotton-growing in this part of the Empire to have their hopes realized.

The present Report supports the view that a Jassid-resistant plant can be grown in Rhodesia, and the striking difference between the behaviour of the resistant and non-resistant types gives direction as to the seed to be propagated for distribution to growers for future planting.

It would probably be unwise on my part to suggest the period that

must elapse before there can be sufficient seed of approved quality available for distribution to growers. Suffice to say that those responsible for the industry in Southern Rhodesia are equally anxious with the growers that that day should dawn soon rather than late. I simply counsel patience—patience and confidence.

The benefits to agriculture which will accrue from the establishment of cotton-growing as a part of the progressive farmers' regular rotation are more than can be visualized, but the advantages are already appreciated by many, and the co-operation between the Government of the Colony and the Empire Cotton Growing Corporation in the interests of the cotton industry augurs well for its future success.

I venture the opinion that the example set in cotton-seed breeding at Gatooma will give a lead to similar activity in regard to other crops that may be suited to the climatic and soil conditions of the Colony.

COTTON-BREEDING STATION, GATOOMA : REPORT FOR THE SEASON 1926-27

BY

J. E. PEAT

(COMMUNICATED BY MAJOR G. S. CAMERON.)

On the whole, the past season has been a satisfactory one for the work of the station. The climatic conditions, though not ideal, have been favourable, and the attacks by insects have been such that a very fair idea of the significance of the various attacks could be formed.

The results from the season 1925-26 were inconclusive. It was realized that Jassid had done a certain amount of damage, but it was impossible to allocate properly the responsibility of the various factors, seasonal and insect, affecting the crop.

From the indications obtained, it was hoped that the records this past season would show Delfos, Express, or RB-R8, a Rustenburg Bancroft selection, sufficiently superior to the commercial Improved Bancroft to justify the multiplication and issue of one of them. Variety trials between these varieties were laid down, and careful observations were taken on them throughout their development. None of these, however, is to any degree Jassid-resistant, and this

season's work on the station, linked up with the observations throughout the country in this and previous seasons, appears to show that Jassid attack is the limiting factor to cotton-growing in the greater part of Southern Rhodesia.

None of the other varieties grown exhibited sufficient resistance to justify bulking, and the greater part of the energies of the station are now being devoted to obtaining good Jassid-resistant single plant lots, observations on these, and the multiplication of the best.

Approximately 250 acres, half the area of the station, have now been stumped, cleared, and ploughed. The remaining acreage will be kept as grazing; this feeding will be supplemented during the dry season by cattle food grown as rotation and trap crops—maize stalks, husks, ensilage, and a certain amount of hay.

Throughout the year the farm and laboratory equipment has been added to; additions and alterations have been made in the laboratory and seed store; a new compound has been erected, and a number of new roads made. It is hoped this coming year to proceed with the first planting of trees and shelter belts, the ground for which has already been prepared.

The Government of Southern Rhodesia has taken a great interest in the progress of the work and has at all times shown its willingness to assist in increasing the efficiency of the station.

SEASON.

Rainfall.—Included are a table (Table I.) giving the rainfall of the station during the past season, and a series of graphs (Fig. 1) showing the rainfall distribution for the past fifteen years at Gatooma. The records for seasons 1925-27 are cotton station records; those for 1912-25 are for Gatooma, and were obtained from the Meteorological Office, Department of Agriculture. The graph for 1926-27 shows clearly the nature of the rainfall distribution during the past season. The total of 33 inches conveys an impression of a heavier rainfall than was available to the plants. The rain fell heavily at four periods, with three fairly long dry intervals between. Owing to the intensity of these four periods of rain a good deal of it was lost. The dry season was long, and the first appreciable rains were late in arriving. These, however, when they came were good. Planting started on November 30 and continued into December. On the old, better worked land, where all the important plots had been planted, the cotton braired in five days, became well established, and appeared not to suffer from the dry spells which followed in the second half of

December and in January. The few trial plots and the bulk cotton planted on new land about the middle of December suffered greatly, however, from the January drought, and gave a very much poorer yield than the plots on the old land.

TABLE I.
RAINFALL RECORD (JULY 1926-JUNE 1927).

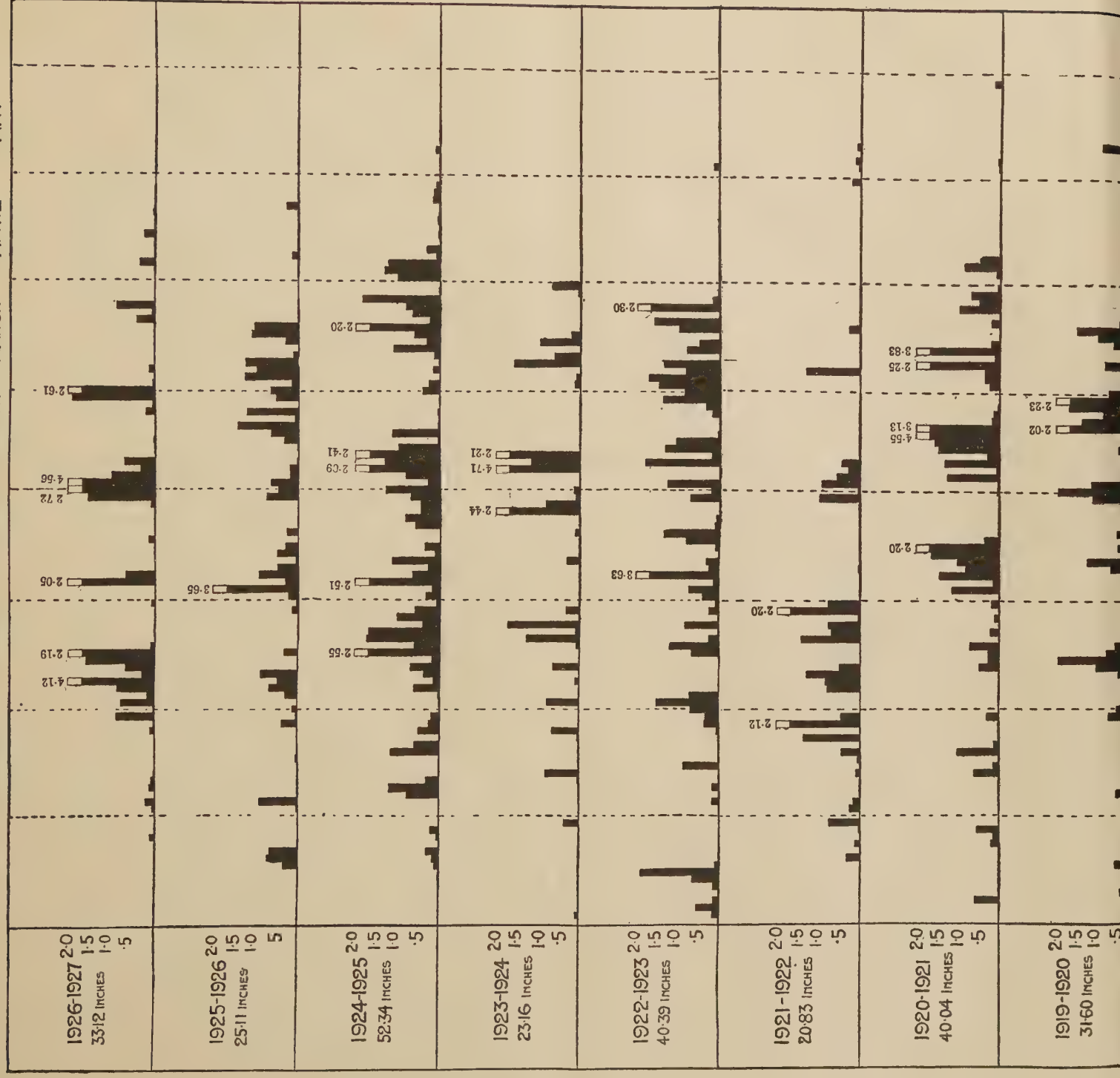
1926.		<i>Inches.</i>	1927.		<i>Inches.</i>
July	..	Nil	January	5	1.90
August	..	Nil	"	6	0.15
September	..	Nil	"	8	0.68
October	26	0.10	"	18	0.13
		—0.10	"	28	0.06
November	3	0.04	"	29	0.70
"	4	0.22	"	30	0.84
"	9	0.13	"	31	2.50
"	10	0.06			—6.96
"	12	0.01	February	1	0.22
"	25	0.08	"	2	4.17
"	26	0.02	"	3	0.39
"	29	0.88	"	5	1.01
"	30	0.02	"	6	0.22
		—1.46	"	7	0.12
December	3	0.80	"	8	0.69
"	4	0.17	"	15	0.01
"	6	0.25	"	22	0.22
"	7	0.62	"	25	0.04
"	8	1.87	"	26	1.91
"	9	2.25	"	28	1.67
"	11	0.29			—10.67
"	12	0.44	March	1	0.94
"	13	0.23	"	2	0.03
"	14	0.78	"	7	0.11
"	15	0.80	"	21	0.44
"	16	0.79	"	22	0.02
"	17	1.40	"	23	0.03
"	19	0.06	"	24	0.88
"	22	0.01			—2.45
"	31	0.08	April	5	0.09
		—10.84	"	6	0.26
			"	14	0.26
			"	20	0.03
					—0.64
			May	..	Nil
			June	..	Nil
			Total for Year	..	33.12

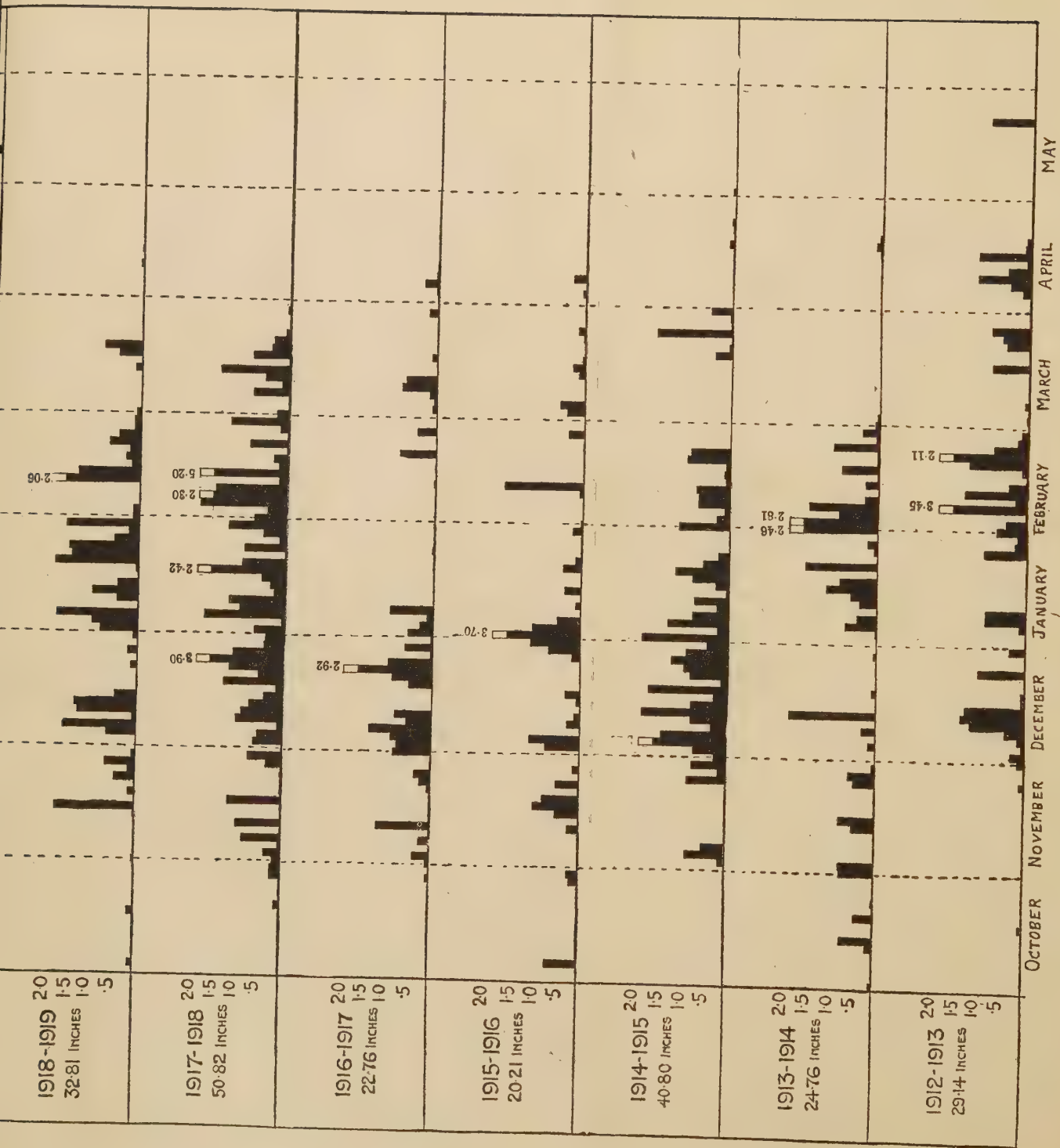
The plot plants were too young to show signs of suffering greatly from the heavy rains which fell in a short period at the end of January and the beginning of February, but the heavy fall at the end of February gave a decided check to flowering, and a stimulus to shedding, as will be shown later when discussing the development curves.

RAINFALL GATOOMA 1912-1927.

FIG. 1

OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY





Apart from this, the distribution of the rain periods and the dry intervals between was favourable to reasonable growth and fruiting for cotton on old land.

The series of rainfall graphs for the past fifteen years (Fig. 1) show the nature of the rainfall distribution which may be expected at Gatooma over a number of years. In most of these years a suitable cotton should have yielded satisfactorily. It would appear that good planting rains cannot be expected before November, and in some years even early December; dry spells may occur in December and January, necessitating good tilth and cultivation, if the plant is not to suffer. A certain amount of physiological shedding from heavy rains in late February and March must be expected and allowed for, but after that little trouble should be caused by late rains.

Temperatures.—The chart of maximum and minimum temperatures (Fig. 2) shows that throughout the greater part of the growing and flowering period the mean maximum temperature was between 75° and 85° F., with a mean minimum of 55° to 65° F. Much higher temperatures than these were recorded in the early part of the season. There was no frost, but in a few days in May, and again a few in June, the minimum temperature was around 37° F. The lowest weekly mean was 40° F.

Humidity records, sun and soil temperature, and thermograph records were also kept. Though sunshine records are not available for last season, the mean number of hours of sunshine per day throughout the season must have been high.

PLANT DEVELOPMENT RECORDS.

There being the hope, from the indications of season 1925-26, that one of the varieties Delfos, Express, or RB-R8 might be sufficiently superior to the commercial Improved Bancroft to be worth issuing, careful development records were kept on these four varieties. Graphs of two of these records are here given (Fig. 3), not so much with the idea now of contrasting them, but as indices of the growth and development of the plants of these varieties under Gatooma conditions, and as analyses of the various factors leading up to the ultimate yield. The general outlines of the graphs for each of the four varieties are similar; hence to simplify the chart the records for Improved Bancroft and Delfos only have been graphed.

The record plots were planted on December 5, rows 4 feet apart, on uniform soil, fertilized with 150 lbs. per acre bone and superphosphate, plus 50 lbs. per acre sulphate of ammonia, which was the general cotton fertilizer dressing on the station for all except a few

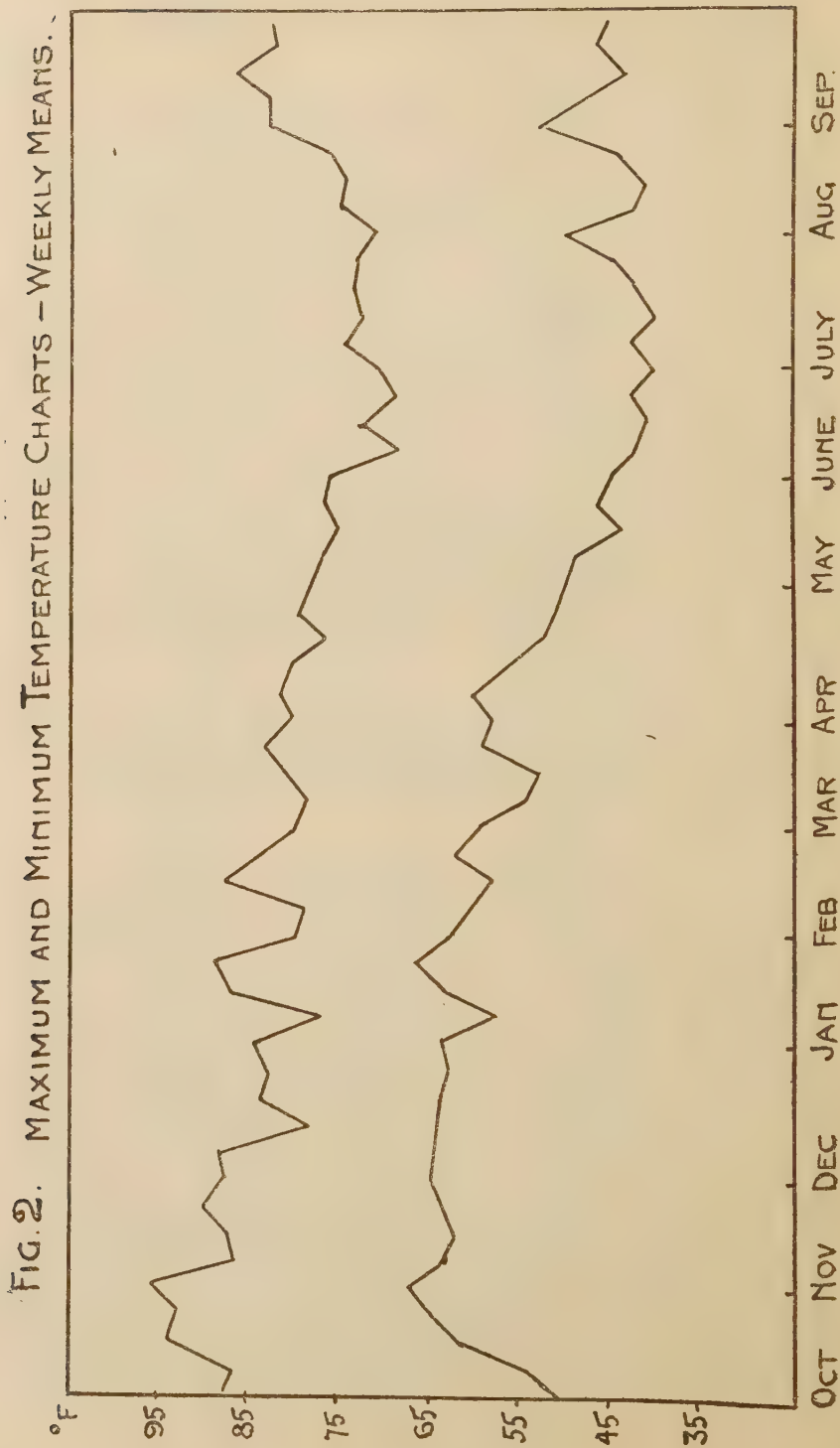
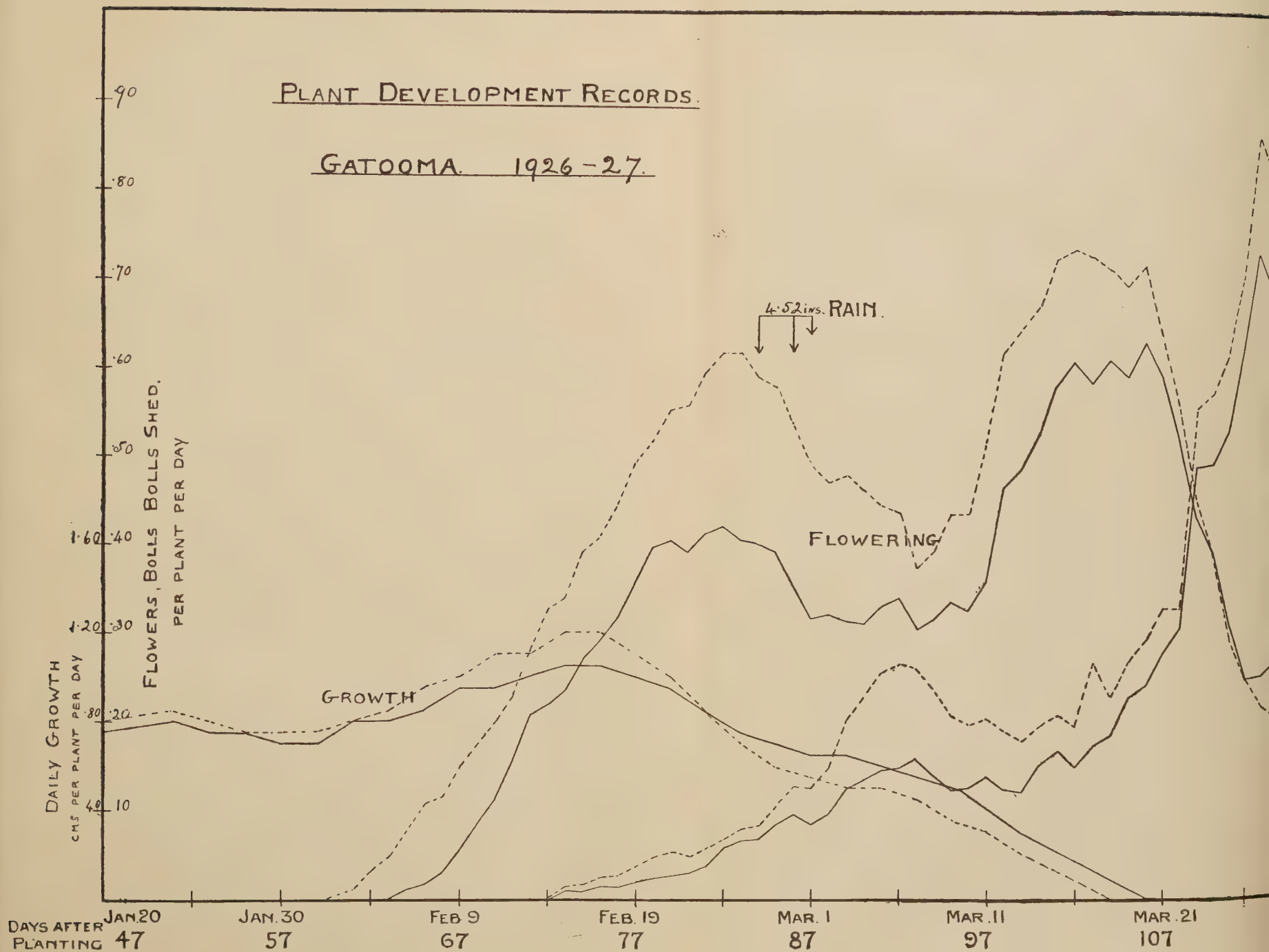
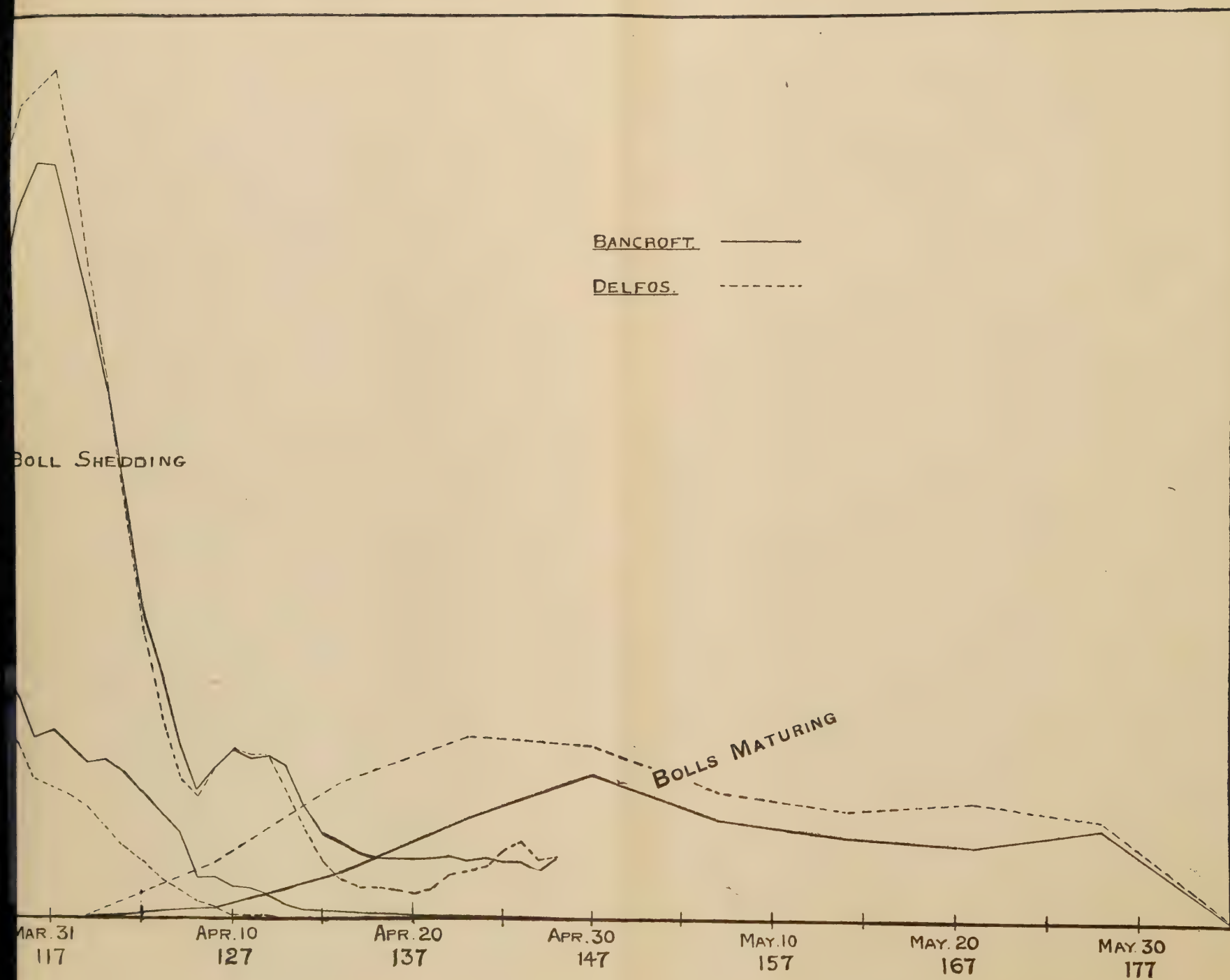


FIG. 3.





special plots. They were thinned on January 4 to a spacing of 10 inches between the plants. Records were taken from four scattered sub-plots for each variety.

Growth records, measuring from the cotyledonary node to the base of the apical bud, were taken every second day, starting with a hundred healthy plants for each variety. Thus each day measurements were taken on two varieties.

Flowering records and boll-shedding records were taken daily on 200 plants for each variety. The shed bolls were separated into those with and without signs of bollworm attack. In the early part of the season bud-shedding records were taken.

Bolling records, again on 200 plants, were taken weekly, the picked bolls being separated into mature and immature bolls, and these classes weighed separately.

In the chart (Fig. 3) the growth has been reduced to growth per plant per day, and smoothed to five-interval, really ten-day, means. The flowering and shedding figures are smoothed to five-day means, and the bolling figures represent bolls per plant per day with weekly pickings.

Growth.—Growth throughout was moderate, fairly even and regular, differing little between the four varieties recorded. The mean plant heights, from the cotyledonary node to the base of the apical bud, at the end of the growing season, were as follows: Improved Bancroft 57.7 cms., Delfos 58.3 cms., Express 56.2 cms., and RB-R8 48.3 cms. The period of maximum growth was around February 16, or seventy-four days after planting.

Growth measurements on the Delfos selection, grown in the mosquito gauze, bee-proof cage, showed the mean rate of growth there this season to be only about half that of the field Delfos. The mean gain in height during the period for the cage plants was 21.6 cms., contrasted with mean gains of 42.0 and 42.3 cms. for field Bancroft and Delfos respectively. The number of plants measured was small in comparison, and it is recognized that there was a difference in soil and strain, but it may safely be said that the growth rate in the cage this season was distinctly less than in the field.

During the measuring period, January 20 to March 17, 25 per cent. of the plants being measured had to be discarded because of damage of one sort or another, chiefly damage to the main stem or apical bud; of those discarded 25 per cent., or 10 per cent. of the plants measured, were discarded because of serious white ant attack.

Flowering.—The flowering curves for all four varieties are similar in outline, though Delfos flowered distinctly more heavily. The heavy rains at the end of February and on March 1 produced a marked diminution in the rate of flowering, which has also affected the shape of a part of the shedding curve. The apparent decline in the flowering curves just before the heavy rains at the end of February is due to the smoothing. The modes of the flowering curves are reached around March 16, about 102 days after planting, and from then the fall away is rapid.

Shedding.—At the end of January and in February, in the Bancroft and RB-R8 plots, records of bud shedding were taken. After February 18, time could not be spared to carry on these records; at that date boll shedding was just commencing, and it is probable that the continued trend of bud shedding follows a line not dissimilar to that of the bolls.

The boll-shedding was enormous, and the extent of this, together with the low weight and the immaturity of the bolls opening, gives a key to the cause of the poor yields in Southern Rhodesia.

In Bancroft a total of 74 per cent. of the bolls formed were shed (14.4 bolls per plant), only 5.0 bolls per plant being carried through to an opening stage; summing the four varieties, 73 per cent. of the bolls formed were shed, 15.3 bolls per plant, only 5.6 bolls per plant reaching an opening stage.

Fig. 4 (p. 125) shows that the extent of this shedding caused by bollworm attack is almost negligible. Of the total shedding only 0.4 bolls per plant (2.3 per cent.) showed marks of bollworm attack, and that almost entirely by Spiny Boll Worm.

The last of the very heavy rains fell three weeks before the shedding curve starts to leap up. The 0.88 inch on March 24, while it probably stimulated the shedding, was obviously not the primary cause. The temperatures (Fig. 2) were still relatively high, the mean maximum being approximately 80° F., and the mean minimum approximately 60° F. In the opinion of the writer, the main cause of the tremendous shedding, of the low boll weights, and of the immaturity of the opening boll, is Jassid attack, which, as will be described later, had by this time become very marked.

Bolling.—The meagreness of the bolling curves is in striking contrast to those for flowering and shedding. But, had all the bolls opening even been mature, the yield would have been very different from that actually obtained. The mean boll weights were dis-

tinely low (Table II.). In Bancroft only 32 per cent. of the bolls opening appeared to the eye to be mature and more or less opening properly, the mean boll weight in this group being 4.6 grms., 104 bolls per lb. of seed cotton. Summing the four varieties, only 35 per cent. of the bolls picked appear to the eye to be mature. The ratio of apparently mature to immature bolls was higher for the first pickings than later.

Owing to the number of immature and only partially opened bolls, it is difficult to give a satisfactory time figure for boll develop-

TABLE II.

	<i>Bancroft.</i>	<i>Delfos.</i>	<i>Express.</i>	<i>RB-R8.</i>
Mean number of buds formed per plant to February 18	16.2	—	—	15.2
Mean number of buds shed per plant to February 18	1.5	—	—	1.4
Mean number of buds shed per plant through bollworm attack to February 18	0.6	—	—	1.1
Mean number of flowers produced per plant	19.5	24.2	16.6	16.7
Mean number of bolls shed per plant	14.4	16.5	9.8	12.0
Mean number of bolls shed per plant through bollworm attack	0.4	0.4	0.4	0.4
Mean number of bolls opening per plant	5.0	7.6	6.3	4.3
Mean number of bolls per plant, obviously immature	3.8	5.5	4.5	3.1
Mean boll weight in this group, bolls obviously immature	2.6 grms.	2.3 grms.	2.2 grms.	2.5 grms.
Mean number of bolls per plant, apparently mature	1.2	2.0	1.7	1.1
Mean boll weight in this group, bolls apparently mature	4.6 grms.	4.0 grms.	3.7 grms.	5.0 grms.
Mean yield per plant	15.4 grms.	20.5 grms.	17.0 grms.	15.0 grms.
Mean boll weight (total pickings) . .	3.1 grms.	2.7 grms.	2.7 grms.	3.5 grms.
Number of bolls to 1 lb. of seed cotton	147	168	168	130

ment for the different varieties; but it may be noted that the bolls of a Delfos selection, grown under normal conditions, isolated from other cotton, and fairly free from Jassid throughout the season, took from 59 to 73 days to develop, with a mean boll maturation period of 66 days. The general results show that the boll maturation period in Rhodesia will be longer than that normally expected.

Not only does the large percentage of immature bolls affect the yield, but it has a considerable effect on the quality of the lint. It is

probable that to this result of Jassid attack, and not mainly to climatic factors, must be attributed much of that weakness and softness of some of the Rhodesian cotton about which certain complaints have been made in the last two years. It is highly probable that this trouble will become very much less when a Jassid-resistant strain is established in the country.

The final mean yields per plant, low because of the heavy boll shedding and the low mean boll weights, are given in Table II., and supplement the variety trial results.

VARIETY YIELD TRIALS.

The three varieties already mentioned—Delfos, Express, and RB-R8—were each tested against, as a standard, the best commercial Improved Bancroft, which had been grown at Gatooma the previous season. The land was uniform, the spacing 4 feet by 10 inches, and the fertilizer application at the rate of 150 lbs. per acre bone and superphosphate, plus 50 lbs. per acre sulphate of ammonia.

Plots of four rows of 66 feet, $\frac{1}{4\frac{1}{2}}$ acre, were used, the usual rows at each end being omitted on account of border effects. Two distinct sets of trials were laid down, one set on old, well-worked land, and one set which of necessity was planted a fortnight later on new land—land ploughed for the first time the previous wet season. In each set there were eight replications of each variety, against eight replications of the standard, on the A B B A principle. Thus, in one block of plots Delfos was tested against the standard, in the next Express against the standard, and in the third RB-R8. The plots on each block were planted on the same day, and thinned on the same day. The plots on the old land were planted from November 30 to December 3, and were thinned on January 3 and 4. On the new land the plots were planted on December 14 and 15, and were thinned on January 7.

In examining the results the method of differences between adjoining plots was used for calculating the standard deviations, and "Student's" method was used for assessing the significance of these differences. The results obtained are summarized in Table III.

When it is considered that about three-quarters of the bolls formed were shed, and of those retained only one-third opened properly, and that this result was brought about mainly through Jassid attack, the yields may be taken as fair. They certainly add weight to the belief that distinctly paying yields will be obtained when a Jassid-resistant strain is multiplied and issued.

With the season experienced, the yields on the new land, where the plots were planted a fortnight later, are very considerably lower than those obtained on the older land with the earlier planting.

While all four varieties yielded unsatisfactorily, there is little to

TABLE III.

VARIETY YIELD TRIALS.

Set I. (Old Land)—Eight Replications each Variety.

	Mean Plot Yield (Lbs.).	Equivalent Yield Per Acre (Lbs.).	Mean Differ- ences (Lbs.).	Equivalent Differ- ences Per Acre (Lbs.).	Standard Deviation of Dif- ferences (Lbs.).	"Student's" Factor Z.	Odds that Differ- ence is Signi- ficant.
Delfos ..	7.47	310	}	- 0.23	- 10	0.79	0.29
Bancroft	7.86	330					
Express	8.52	360	}	- 0.56	- 24	1.22	0.46
Bancroft	9.21	390					
RB-R8	6.53	270	}	- 2.67	- 112	1.05	2.58
Bancroft	9.20	390					

Set II. (New Land)—Eight Replications each Variety.

Delfos ..	5.0	210	}	—	—	—	—
Bancroft	5.0	210					
Express	4.92	210	}	- 0.33	14	0.92	0.36
Bancroft	5.25	220					
RB-R8	4.28	180	}	- 0.46	19	0.70	0.66
Bancroft	4.74	200					

choose between them on this year's showing. RB-R8 was significantly a poorer yielder. Delfos, though it flowered much more heavily than the other two, produced much the same yield because of the smaller boll weight.

SPACING TRIALS.

The best commercial Bancroft seed was used, and, as in the variety trials, two separate sets were planted, one on old land from December 4 to 7, and one on new land from December 11 to 13. Rows were 4 feet apart, and the fertilizer application was at the rate of 150 lbs. per acre bone and superphosphate, plus 50 lbs. per acre sulphate of ammonia. The plot size was four rows of 60 feet, $\frac{1}{4}$ acre. The same principles in layout and analysis of the results were adopted as in the variety trial plots. A spacing of 12 inches in the row was taken as a standard: 6 inches, 18 inches, and 24 inches were

tested against it. There were eight replications of each spacing, and each time eight replications of the standard, in each set. The results obtained are summarized in Table IV.

The very marked differences in yields between the plots on the old and new land are again noticeable. With the season experienced, and the variety used, a spacing in the row of under 12 inches would have given the best results, at a spacing of 4 feet between the rows.

TABLE IV.

SPACING TRIALS.

Set I. (Old Land)—Eight Replications each Variety.

<i>Inches.</i>	<i>Mean Plot Yield (Lbs.).</i>	<i>Equivalent Yield Per Acre (Lbs.).</i>	<i>Mean Differences (Lbs.).</i>	<i>Equivalent Differences Per Acre (Lbs.).</i>	<i>Standard Deviation of Differences (Lbs.).</i>	<i>"Student's" Factor Z.</i>	<i>Odds that Difference is Significant.</i>
6 ..	7.01	320	} +0.68	+32	0.42	1.62	540:1
12 ..	6.34	290					
18 ..	7.18	330	} -0.51	-23	1.09	0.46	7:1
12 ..	7.55	350					
24 ..	6.17	280	} -1.18	-54	1.20	0.98	60:1
12 ..	7.35	340					

Set II. (New Land)—Eight Replications each Variety.

6 ..	3.44	160	} +0.76	+35	0.75	1.01	63:1
12 ..	2.68	120					
18 ..	2.15	100	} -0.68	-31	0.51	1.34	210:1
12 ..	2.83	130					
24 ..	2.32	110	} -1.13	-52	0.75	1.51	382:1
12 ..	3.45	160					

6-inch spacing in the row gave a significantly heavier yield than 12-inch. It will be necessary to work out over a number of years the spacing in the row for the resistant variety or varieties issued, but from these results it would seem that the standard spacing at present adopted, 8 to 10 inches, is quite a reasonable one for a medium type of plant.

OBSERVATIONS ON MISCELLANEOUS VARIETIES.

Not one of the other varieties grown was suitable for present multiplication and issue, although, from several, good single plant selections have been made. Series of rows of thirty-three different

varieties and strains were grown. The yields obtained depended very largely on the general response of the plants to Jassid attack.

The following table (Table V.) gives an indication of the more interesting yields obtained. All the observation plots were planted at 4 feet by 2, and received similar treatment, but there were probably slight soil variations, for which no allowance can be made, and the stand varied from row to row.

TABLE V.

<i>Variety.</i>	<i>Yield of Seed Cotton per Plot (Lbs.).</i>	<i>Number of Rows in Plot.</i>	<i>Yield Per Row (Lbs.).</i>	<i>Equivalent Yield per Acre (Lbs.).</i>
Cambodia 440 ..	14.75	4	3.69	677
Cambodia 664 ..	24.12	7	3.45	634
Cambodia	47.81	14	3.41	627
Improved Bancroft (Imported A.W.S.)	121.31	56	2.17	405
Improved Bancroft (Bulk Selection)	72.12	35	2.06	378
Arizona	69.00	40	1.72	313
"Over the Top" (Strain B)	41.31	36	1.20	220
Durango	9.56	21	0.45	83

In contrast with the others the Cambodia yields are very promising, as most of the plants were of an unproductive type, spaced 2 feet in the row, and the stand was only fair.

Cambodia was practically Jassid-immune, but most of the plants were exceedingly lax in habit and late maturing (Plate II.). The mean staple length was short. As will be described later, some very promising, reasonably compact, long staple Cambodia selections were made. "Over the Top" Strain B, from Nyasaland, though compact and a heavy fruiter, possessed only a fair degree of Jassid resistance, and the staple throughout was short. Arizona was only fair, and Durango was so Jassid susceptible that it gave an exceedingly poor yield (Plates I. and IV.).

The varieties ordered from the United States did not arrive in time to be planted out during the season under review, but they will be included in the next.

INSECT ATTACK: JASSID.

As has been indicated at various stages already in this report, Jassid attack has been the limiting factor to cotton yields on the station this year, and, from all the observations made, would appear

to be the limiting factor to cotton-growing as a whole in this country.

It was only as the season advanced that the full significance of the Jassid attack was appreciated. Acknowledgment must be made here to the inspiration and help given by the reports of Parnell at Barberton on Jassid and his work with resistant strains. Many of his experiments and observations were repeated, and his results confirmed under Rhodesian conditions. The writer was privileged to visit Barberton in May, and several of the Barberton resistant strains will be grown under observation and multiplied this coming season at Gatooma.

Incidence.—Occasional Jassids were noticed to be present as early as the middle of January at the time the cotton was thinned. By February 21 the effects of the attack were becoming noticeable on the varieties on the trial plots. They displayed a slight red discoloration, and counts made showed as many as eight to ten nymphs per leaf on some plants. During the next fortnight the effects of the attack became every day more noticeable, especially in the varieties Delfos and Durango. It was during this period that the enormous increase in boll shedding took place, shown by the sharp rise in the shedding curves. By the end of March most of the varieties in the plots were showing distinct signs of attack. Delfos and Durango were showing up very badly, and a great many of the primary single plant selections, previously made, had to be discarded because of Jassid susceptibility. Certain progeny rows and single plants were showing good resistance, Nyasaland "Over the Top" fair resistance, and the Cambodias no signs of attack, nor to that date had Jassid nymphs been found on their leaves. For the remainder of the season the symptoms of attack grew steadily worse, but to the end certain single plant selections showed good resistance and the Cambodias a very high degree of resistance, practically immunity (Plates II. and VII.).

It must be borne in mind that plants and strains possessing medium powers of resistance were attacked to a greater degree by reason of being grown in close proximity to very susceptible varieties, veritable Jassid breeding grounds, than they would have been had they been grown in isolation. Certain Delfos single plant selections (Plate V.), grown isolated from other cotton, were only slightly attacked and that late in the season. It has been noticed, too, that odd fields or farms in a particular district have suffered less from Jassid attack than their neighbours, and have thereby obtained higher yields.

A great deal depends on the state of maturity of the plant at

the time that particular observations are made. The symptoms of attack develop most clearly during the period that the plant is developing its bolls—a period of stress; thus an early maturing strain may appear to have less resistance at a given date than a later maturing one, though the ultimate yield figures do not support this.

Symptoms of Attack.—The symptoms of a bad attack exhibited at Gatooma agreed with the descriptions given by Parnell. At first a slight reddening of the leaves appeared, which, as the season advanced, became deeper; the majority of the leaves crumpled up, became brittle and dead. A few of the earlier bolls appeared to reach maturity; the large majority were shed, and the remainder, not fully grown, opened immaturely or imperfectly (Plates VI. and VII.). The resultant yield of seed cotton was only a fraction of what might reasonably have been expected had there been no Jassid attack, and the quality probably very much poorer.

Portable Cage Experiments.—Selected pairs of Delfos, Bancroft, and Cambodia plants were caged with fine gauze portable cages and fumigated by sprinkling calcium cyanide dust on the soil underneath. After an interval of ten days they were again fumigated in the same way. Two days later some 200 to 300 Jassid nymphs were introduced into one of each pair. Similar results to those recorded by Parnell were obtained. The Delfos and Bancroft plants with introduced nymphs showed increasing signs of Jassid attack, while the controls recovered to some extent.

The Cambodia plants with introduced nymphs began to show signs of attack ten days after the introduction, although the controls and neighbouring plants in the plot were free from the symptoms. At first there was a slight general colouring of the leaf, with a reddening and curling towards the edges. Later this developed into a distinct withering at the edges and tips of the leaves. It was noticed that nymphs placed on the hairy Cambodia leaves showed signs of discomfort, and were not so active as on the leaves of less hairy plants; but the Jassids introduced into the Cambodia cages, during the three weeks that they were there, lived, appeared healthy, and caused the appearance of the symptoms of Jassid damage. Thus Jassids, if forced to, can live, thrive, and cause the appearance of the symptoms of attack on what in the field are practically immune plants.

Leaf Ring Experiments.—Parnell's glass ring experiments were repeated on Bancroft, Delfos, and Cambodia with results similar to those obtained by him. The tissue inside the cell area of the cells, with introduced nymphs, in two days became discoloured light

brown, more marked in the centre area of the cell, and a greenish yellow towards the ring wall. When the nymphs were allowed to remain in the cell, the tissue inside the ring died in a few days more, became brittle, and could be pushed out. The discoloration did not spread from the cell area, and the immediately surrounding tissue still appeared perfectly healthy. Similar results were obtained when using Cambodia leaves. Control cells were unaffected.

Each time the nymphs were introduced to feed on the under-surface of the leaf, as is their natural habit, but invariably the discoloration appeared first on the upper surface of the leaf, and almost to the end the appearances of attack were intenser there than on the lower surface. The whole central area within the ring at quite an early stage of the discoloration was deeply opaque when held to the light, and, in this respect, entirely different from the surrounding tissue. When examined through a hand lens this tissue presented a scorched appearance, and seemed to be raised in a large number of small blisters, possibly each blister representing a site of puncture.

Transverse sections were made through this tissue. The discoloration was seen not to be continuous throughout the field of view, the chloroplasts in groups of adjoining cells being stained a ruddy brown as though surrounding the place of puncture, but chloroplasts of other cells near by were only slightly stained or unstained. The staining was more marked in the palisade tissue than in the spongy parenchyma; this was probably due to the more scattered cells and larger air spaces of the latter, any one cell having a greater chance of being removed from a site of puncture, and hence the greater discoloration of the upper leaf surface in the glass rings experiments.

There was marked discoloration along the course of the minor vascular bundles, and deep staining in the sections through the bigger bundles. Though much work has to be done before the true nature of the damage is determined, the observations made on the appearance of the affected tissues support the view that the plant is slowly poisoned; that the damage is caused by the injection of a toxic secretion by the feeding insect, rather than by the carrying of a disease organism. In the leaf rings experiment it would appear that at first only the cells close to the site of puncture are heavily discoloured, and ultimately only the tissue within the ring dies. The spreading effect of the possible toxic action is not great. As was seen in the Cambodia cage experiment, the first visible results of a general attack are seen at the leaf edges, the spreading effect of the possible toxic secretion being firstly outwards to the leaf edge.

Hairiness and Resistance.—A morphological explanation of field



PLATE I.—DURANGO (25/5/27)
High Jassid susceptibility.



PLATE II.—CAMBODIA (25/5/27)
Practically Jassid-immune, but lax in habit
and late maturing.



PLATE III.—G.E.-8 (25/5/27)
Resistant progeny row—early maturing.



PLATE IV.—TYPICAL DURANGO PLANT (25, 5/27)
Highly Jassid susceptible.



PLANT V.—DELFOF PLANT (25/5/27)

Probably Jassid susceptible, but grown isolated from other cotton, and fairly Jassid-free throughout the season.



PLATE VI.—TYPICAL IMMATURE, IMPERFECTLY OPENED, BANCROFT BOLLS FROM JASSID-ATTACKED PLANTS



PLATE VII

Above : Fair average Bancroft bolls.
Below : Good Cambodia bolls from an adjoining plot.



PLATE VIII.—STAINERS COLLECTED FROM THE TRAPS AND
 HANDPICKED FROM THE PLANTS

resistance would appear to suffice, although certain other factors influence the degree and expression of this resistance—*e.g.*, factors influencing the general health and vigour of the plant, and the stress which fruiting lays upon it.

Speaking generally, it has been found this season at Gatooma, as was found by Parnell, that the hairier the plant the greater has been its resistance to Jassid attack, both the density of the hairs on the leaf and their length being taken into consideration.

Among the varieties and strains recorded the order of hairiness was also the order of resistance. It is recognized that the varieties dealt with were not uniform, and that there was considerable variation within the variety or strain examined, but the results obtained are still very significant. Plants as representative as possible of the material being examined were chosen. Twenty-five full-grown leaves, approximately of the same size and age, were taken for each variety. With a sharpened steel punch an area near the point of junction and between the two main veins was removed. The number of hairs on each of these areas was counted under the dissecting microscope, and the figures reduced to hair density per square millimetre.

At the same time thin sections were taken from the middle lamina, and from close to the point of junction of the main leaf veins, in five leaves of each variety or strain, and twenty-five of the longer hairs measured with the aid of a micrometer eye-piece. The results obtained are given in Table VI. They show that the order of hairi-

TABLE VI.
HAIRINESS AND RESISTANCE.

<i>Variety or Strain.</i>	<i>Hairs per Sq. Mm.</i>	<i>Mean Maximum Hair Length—Lamina (Mm.).</i>	<i>Mean Maximum Hair Length—Main Veins (Mm.).</i>	<i>Resistance.</i>	<i>Order of Resistance.</i>
Cambodia ..	6.6	1.1	1.4	Practically immune	1
G.B.-10 ..	8.6	0.7	0.9	Very good	2
G.B.-2 ..	6.9	0.9	1.3	Very good	3
"Over the Top" (Strain B)	7.2	0.8	1.2	Good	4
Z.-1 (First Bulk)	7.0	0.8	1.2	Fairly good	5
Bancroft ..	6.4	0.8	1.3	Fair	6
RB-R8 ..	5.8	0.6	0.8	Fair	7
Express ..	3.2	0.7	1.3	Slightly resistant	8
Delfos ..	2.0	0.8	1.1	Bad	9
Durango ..	0.9	0.7	1.2	Very bad	10

ness, taking into consideration both hair density and hair length, is the order of resistance.

Next season it is proposed to make counts of the infestation of nymphs per leaf for the recorded strains throughout the season. Table VII. shows nymph infestation counts which were made on twenty-five leaves for each of several varieties and strains on April 19, by which date the attack was well advanced. Only general counts had been made before that date; other later counts were made. Durango by that time had been so badly attacked that Jassids were leaving it for better material, hence its slightly lower nymph infestation.

TABLE VII.
COUNTS OF JASSID NYMPHS, APRIL 19, 1927.

<i>Variety.</i>	<i>Jassid Nymphs on 5 Leaves each of 5 Plants—25 Leaves of Each Variety.</i>	<i>Resistance.</i>
Cambodia	1	Practically immune.
G.B.-10	9	Very good.
"Over the Top" (Strain B)	6	Good
Z.1 (First Bulk)	11	Fairly good.
Bancroft	50	Fair.
RB-R8	103	Fair.
Durango	82	Very bad.
G.B.-13	144	Very bad.

Considered with Table VI., it shows that the order of nymph infestation is closely related with the order of hairiness, and that, with the order of resistance; that few nymphs hatch out on hairy plants, and for that reason these escape attack.

Fertilizer Plots.—Observations were taken on plots of a Bancroft selection with differing fertilizer and manurial treatments; plots with kraal manure, 2 tons to the acre; ashes, 1 ton to the acre; bone and superphosphate and potash, 250 lbs. per acre; bone and superphosphate, 400 lbs. per acre; and a plot with no fertilizer application. No differences could be observed between the plots in the degree of Jassid attack.

STAINERS (*DYSDERCUS* spp.).

The observations of the last few years have shown that stainers will probably always be a serious pest in this country. This season marked success was met with on the station by trapping and hand picking (Plate VIII.). There would appear to be no economic reason why this should not be done on a farm scale when cotton is properly established.

During the dry season such precautions as were possible were taken to destroy overwintering stainers, by burning old cotton stalks and grass around the lands.

On February 7 the first stainers, adults, were seen on plants. By the end of February stainers were seen frequently in the plots and were increasing in numbers. On March 1 traps were put down throughout the $8\frac{1}{2}$ acres where the selection and experimental plots were laid out. This was three weeks after flowering had commenced, and about five weeks before the first bolls were due to open.

Some eighty traps served the $8\frac{1}{2}$ acres. Each trap consisted of a few ounces of cotton-seed placed under a bushy and shady cotton plant. The traps to be really successful had to be in good shade and kept moist. When first laid down the weather was showery; later on they were watered every second or third day. The old traps were lifted and new seed put down every fortnight, by which time they had begun to be attacked by white ants, and broods of young stainers were hatching out on them. First thing every morning and before sundown a "piccanin" collected the stainers from the traps and from the plants near by, into a tin containing a dip solution.

On April 20 the traps were removed. By this time bolls were opening freely, and they appeared to have a greater attraction for the stainers than the seed of the traps. Boys were then sent round to hand-pick from the plants; no count was kept of the number so killed.

Some 30,000 adult stainers were caught and killed on the $8\frac{1}{2}$ -acre block during the period that the traps were down, many of them heavy with eggs. In addition to these, hundreds of young broods hatched out and were destroyed on the traps.

Table VIII. gives a record of the catches. The morning pickings were slightly heavier than those of the afternoon. The heaviest catches were obtained on dull days and after rainy nights.

TABLE VIII.

WEEKLY STAINER CATCHES, TRAPS, AND PLANTS, $8\frac{1}{2}$ -ACRE EXPERIMENTAL BLOCK.

<i>Week Ending—</i>					<i>Stainers Caught</i>	<i>Total Stainers Caught</i>
March	7	..	..	..	2,621	2,621
"	14	..	..	..	2,562	5,183
"	21	..	..	..	3,291	8,474
"	28	..	..	..	4,148	12,622
April	4	..	..	..	3,087	15,709
"	11	..	..	..	3,490	19,199
"	18	..	..	..	5,790	24,989

Throughout the country this has been reported as a season of mild stainer attack, probably because of the long dry season and the distribution of the rains. But the stainers destroyed on the station represented, had they been allowed to multiply, a possible infestation of hundreds of thousands of adults at the time the crop was ripening. As it was, there was little staining amongst the mature cotton picked.

In a 45-acre block of bulk cotton, traps were laid along every tenth row, at fairly wide intervals under the shadiest plants. This cotton was late, and the traps were not put down until March 23. By the end of April, when counting was stopped, 17,500 adults, many of them heavy with eggs, had been caught and killed, and hundreds of young broods destroyed. The collecting was done by two "piccanins," who continued hand-picking after the traps were lifted. On a farm scale traps might be visited only once a day or every second day, but, if neglected, they serve merely as an early breeding ground for stainers.

No work has been done on the natural food plants and winter hosts of the stainer, but they have been observed, in the winter, feeding on various species of hibiscus, on *Thespesia garckeana*, and on the fallen fruits of the baobab (*Andansonnia digitata*), a malvaceous, or, more strictly, a bombacaceous, tree common in certain districts.

BOLLWORMS.

This season the shedding due to bollworm attack has been very small (Fig. 4), and that almost entirely due to Spiny Bollworm.

Though in the plant development record plots 73 per cent. of the bolls formed were shed, only 2.3 per cent. of these showed signs of bollworm damage.

There was no American Bollworm attack, nor were there reports of American Bollworm damage throughout the country this season. Possibly the long dry season, the late arrival of the first rains, and their distribution, were responsible for the wiping out of the first broods.

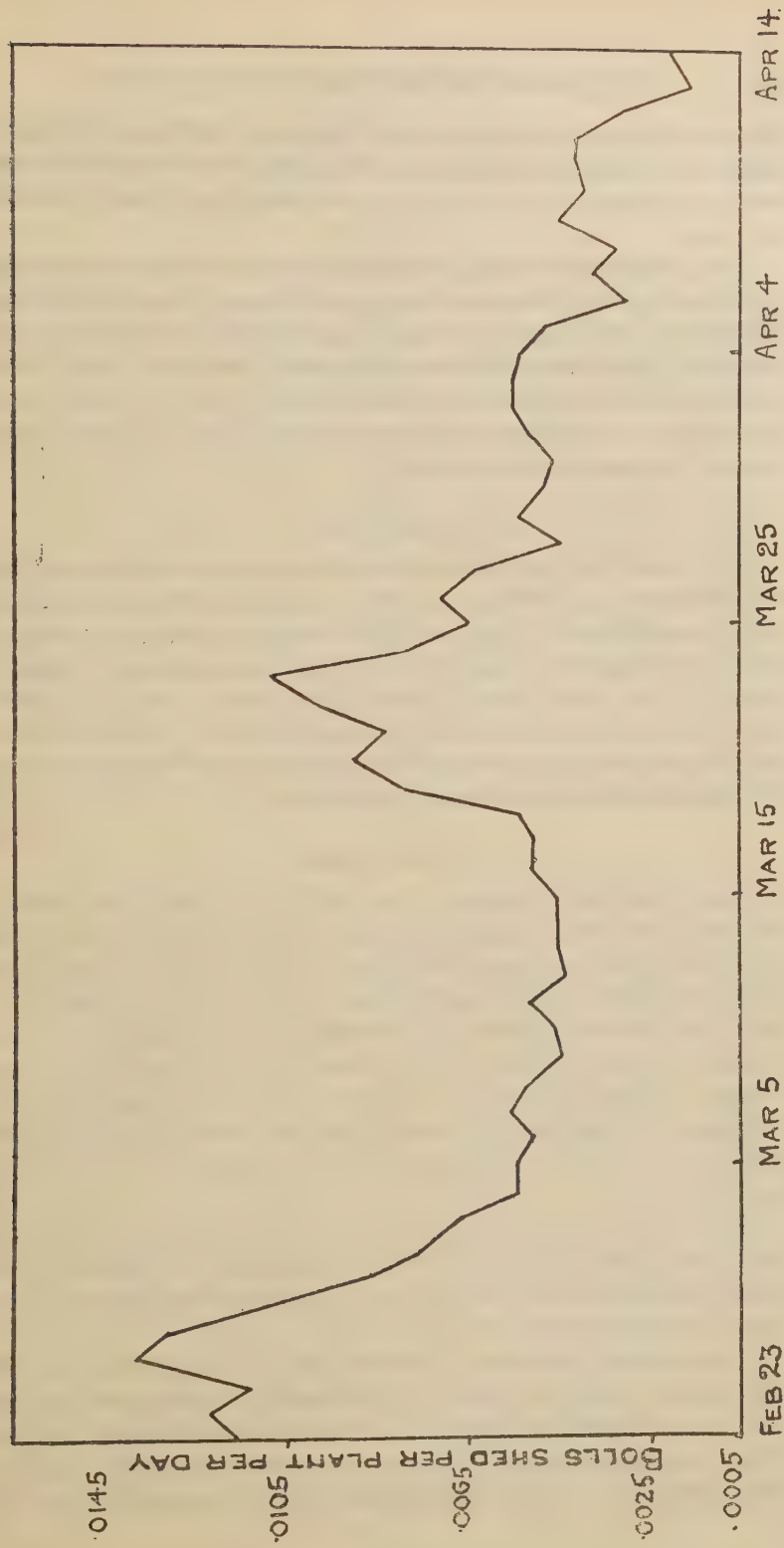
As considerable shedding was caused on the station last season by American Bollworm attack, trap crops of late-planted maize and sweet corn were put down, but these also were unattacked.

APHIS.

During two or three periods aphid was troublesome on the plots, but each time it was kept in check by natural enemies, by syrphid larvæ, by ladybirds and by ladybird larvæ, which appeared to multiply very rapidly at the times of worst attack. The worst attacks

Fig. 4.

BOLL WORM SHEDDING.



were during two of the dry periods following the periods of heavy rains, which were characteristic of the season; one around the third week in January, and the other in the second and third weeks in February.

It was observed that the attacks were worse and continued longer on the very hairy plants such as Cambodia, and that these plants showed signs of suffering more than the more glabrous plants, probably because of the fewer natural enemies present on them. There were fewer ladybirds, ladybird larvæ, or syrphid larvæ on them; these appeared to suffer discomfort from the hairs, and were less active than on the more glabrous plants.

WHITE ANTS.

White ants were troublesome during the dry period in the second half of January and February. They ate into the stems at and just above ground level. In the plant development plots 10 per cent. of the plants originally selected for growth measurements—normal, healthy plants when chosen—were killed through white ant attack in the period between January 20 and March 18. Such an attack precludes for the present any idea of carrying out graded spacing experiments or exact small scale plant trials.

PROGENY ROWS.

In all, sixty-seven progeny rows, each 5 by 2 feet, were planted out from selections in Bancroft, Delfos, Express, Trice, Acala, and Z.1. Most of these have been discarded because of insufficient Jassid resistance. Those retained are not only resistant, but have other qualities making them vastly superior to the commercial cotton at present grown. The best bolls, about fifty from each row, from twenty discarded Bancroft rows gave a mean boll weight of only 3.6 grms., 126 bolls per lb. seed cotton, and from fifteen discarded Express rows a mean boll weight of only 3.2 grms., 143 bolls per lb. seed cotton.

The mixed bulk from two rows, G.D.-4 and B.Z.1-1, will be multiplied under observation this coming season. In Table IX. are given the analyses of re-selections from them, which will be grown again in progeny rows.

The mean weight of seed cotton per boll was obtained from the five best mature bolls per plant. In measuring the lint length, ten seeds for each plant were combed, a tuft of hairs was pulled, laid on a black velvet pad, and the mean maximum lint length measured with a steel rule. In calculating the ginning percentage, the lint

index and the mean weight of 100 seeds, from 100 to 300 seeds with lint attached were weighed, ginned in a Platts' 4-inch gin, and the ginned seed weighed again.

TABLE IX.

<i>Strain.</i>	<i>Mean Weight of Seed Cotton per Plant (Grms.).</i>	<i>Mean Weight of Seed Cotton per Boll (Grms.).</i>	<i>Mean Maximum Lint Length. (Mm.).</i>	<i>Ginning Percentage.</i>	<i>Lint Index (Grms.).</i>	<i>Mean Weight of 100 Seeds (Grms.).</i>
G.D.4-6 ..	82	5.5	27.6	32.3	5.89	12.13
„ 7 ..	129	5.8	28.6	31.6	5.49	11.86
„ 8 ..	68	5.6	28.0	30.7	5.43	12.26
„ 9 ..	50	4.6	28.1	32.9	5.87	11.95
Mean ..	82	5.4	28.1	31.9	5.67	12.05
B.Z.1-1-2..	38	5.8	29.6	29.6	5.90	13.98
„ -4..	38	5.4	29.6	28.7	5.08	12.56
„ -11..	105	6.0	30.9	30.1	5.34	12.41
Mean ..	50	5.7	30.0	29.5	5.44	12.98

Table X. gives the analyses of some of the more interesting re-selections which will be grown in progeny rows again this coming season.

TABLE X.

<i>Strain.</i>	<i>Mean Weight of Seed Cotton per Plant (Grms.).</i>	<i>Mean Weight of Seed Cotton per Boll (Grms.).</i>	<i>Mean Maximum Lint Length (Mm.).</i>	<i>Ginning Percentage.</i>	<i>Lint Index (Grms.).</i>	<i>Mean Weight of 100 Seeds (Grms.).</i>
G.B. 8-13	57	4.9	28.0	32.3	4.98	10.43
„ 10-15	139	4.0	28.2	32.4	4.77	9.94
„ 15-58	112	4.2	27.4	33.5	4.99	9.87
G.A. 1- 5	52	5.5	29.0	33.0	5.88	11.92
„ - 6	130	4.3	26.8	33.7	5.69	11.17
„ -17	182	4.3	27.2	32.2	6.12	12.88

All plants in the progeny rows were selfed; as the season advanced those rows which were obviously unsatisfactory were dropped. The system of selfing adopted was that of tying up the flower buds with wool or thread the afternoon before opening. A gang of boys as a routine operation went round the progeny rows plots each afternoon, and in the morning tagged the flower stalks. This method was found easier, simpler, and more economical than sewing, or fastening on

small netting bags, though the latter method was used in crossing work.

A number of Barberton resistant, mixed bulk and special plant lots will be multiplied under observation this season. It is probable that one or more of these will be found suitable for immediate bulking and issue, while purer, more uniform, and possibly better strains are being worked up.

SINGLE PLANT SELECTIONS—SEASON 1926-27.

A great deal of time was spent this season in single plant selection work, and though, as the season advanced, a great many of those made had to be discarded for one reason or another, some very promising selections have been obtained.

Cambodia was undoubtedly the most striking variety grown on the station this past season, though the majority of the plots were extremely lax in habit and short in staple. Table XI. gives analyses of some of the more promising Cambodia selections retained. The plant spacing was 2 by 4 feet.

TABLE XI.

<i>Strain.</i>	<i>Mean Weight of Seed Cotton per Plant (Grms.).</i>	<i>Mean Weight of Seed Cotton per Boll (Grms.).</i>	<i>Mean Maximum Lint Length. (Mm.).</i>	<i>Ginning Percentage.</i>	<i>Lint Index (Grms.).</i>	<i>Mean Weight of 100 Seeds (Grms.).</i>	<i>Remarks.</i>
C.1. ..	61	8.0	26.9	39.1	7.95	12.36	Plant growth moderate.
C.2. ..	104	7.6	27.7	37.8	7.84	12.85	Plant tall and lax.
C.3. ..	85	—	29.4	33.7	6.63	13.01	Plant tall and lax.
C.4. ..	138	7.3	31.6	35.5	7.03	10.54	Plant medium lax.
C.6.A.	96	—	27.7	36.1	6.63	11.77	Plant compact.
C.7. ..	101	7.8	27.9	37.7	7.69	12.61	Plant growth moderate.
C.8. ..	134	7.5	28.4	37.1	6.81	11.52	Plant moderately compact.
C.10. ..	138	8.4	28.2	36.2	7.37	12.94	Plant lax.
C.15. ..	153	7.4	28.9	38.3	7.86	12.62	Plant lax.

The attempt was made to pick mainly plants of a fairly moderate and compact type. The yielding and lint qualities of those chosen appear to be good. The high boll weights, high seed weights, high

ginning percentages, and high lint indices are especially striking. Should they do as well next year in progeny rows one or more will be bulked up. It would be interesting to note their behaviour on heavier land and in a wet year.

A general difficulty was found in getting hairy resistant selections with a good lint length and other desirable qualities, the great majority of the more hairy plants having short staple. Table XII. gives analyses of some of the more promising selections retained. Most of the plants were at spacing 4 by 2 feet, but some were at 4 feet by 10 inches.

They vary somewhat in the degree of Jassid resistance possessed, so the progeny rows will be grown this coming season alongside very susceptible strains, which will serve as indices of attack, and as Jassid breeding grounds.

TABLE XII.

	<i>Mean Weight of Seed Cotton per Plant (Grms.).</i>	<i>Mean Maximum Lint Length (Mm.).</i>	<i>Ginning Percentage.</i>	<i>Lint Index (Grms.).</i>	<i>Mean Weight of 100 Seeds (Grms.).</i>
A O (Arizona) - 1	60	32.2	31.3	5.32	11.68
A O " - 3	66	28.2	34.5	6.30	11.94
B - 1	50	30.2	35.1	6.92	12.78
B - O - 1	46	30.4	35.0	7.41	13.74
B - O - 2	65	28.4	33.2	7.20	14.28
RB - R8 - 1	79	28.8	31.8	5.62	11.99
" - 3	59	30.0	33.1	5.67	11.45
" - 6	73	28.2	36.8	6.77	11.61
" - 7	78	28.2	34.4	6.97	13.28
" - 12	91	29.0	32.6	5.89	12.14
O - B "Over the Top" - 2 (Strain B)	209	25.9	34.2	5.76	11.05
O - B "Over the Top" - 3 (Strain B)	61	26.0	36.2	5.58	9.82
U (Uganda) - 1	77	29.7	31.9	4.22	8.99
K Z - 1	50	30.2	30.6	4.59	10.41
K Z - 3	108	31.3	30.7	4.83	10.86

CROSSES.

A number of crosses were made between compact, long-stapled Bancroft and Delfos plants possessing no great degree of Jassid resistance, and the more compact of the practically immune Cambodia plants. A number of the F.1 progeny have been grown through the winter in tins and are, at the time of writing, being back-crossed

with long-stapled, compact, early maturing, but not markedly resistant parents. The seeds from these back-crosses it is hoped will be planted out this coming season and back-crossed again with long-stapled, compact parents. A number of new crosses will be made next year with what, in the light of the plant analyses, will prove possibly to be more desirable parents.

In May the station was visited by Sir James Currie, Mr. Milligan, and Mr. Jefferys, and in June by Sir William Himbury and Mr. Astley Bell. Other distinguished visitors to the station included His Excellency the Governor, Sir John Chancellor, the Honourable the Minister of Agriculture and Lands, the Honourable the Attorney-General and Minister of Defence, Sir Ernest Montagu, and the Secretary, Department of Agriculture and Lands.

Grateful acknowledgment is hereby made of the assistance rendered by Mr. A. H. McKinstry, who from December shared with the writer the work of the year.

APPENDIX A.

THE ACID TREATMENT OF SEED.

During the last two seasons a certain quantity of the cotton seed has been treated before planting with concentrated sulphuric acid. The seed was immersed in acid for a period of five minutes, washed through four separate water tanks, and then dried.

In season 1925-26, when much of the planting had to be done in a dry seed bed, a light rain germinated most of the treated seed and caused it to braird, but only germinated a small percentage of the untreated seed. A dry spell of ten days followed. Many of the young seedlings died off, and the remainder received a severe check. A good shower came about the middle of December, sufficient to germinate and braird the remainder of the seed. Thus, though a better primary stand was obtained from the treated seed, the ultimate stand was better on the plots where the seed had not been treated. In a country where light erratic planting rains may be expected, if planting dry is ever done, the earlier and easier germination of the treated seed is a doubtful benefit. A shower insufficient to cause the majority of the untreated seeds to germinate may not be sufficient to carry through the young seedlings from treated seeds until further showers fall.

During the past season when optimum planting rains were experienced, there was no difference in the time taken to braird by seedlings from treated and from untreated seed, nor was there any apparent difference in the subsequent growth of the plants. Plants on both plots had begun to braird five days after planting, and a complete stand was obtained in both.

Unless for the treatment of imported seed with a view to the destruction of definite suspected pests and diseases, the treatment in Southern Rhodesia of cotton-seed with concentrated sulphuric acid would appear to be unnecessary, and, on a farm scale at least, commercially uneconomical.

Untreated seed can be used with planters; for easier planting ordinary ginnery delinted seed, or seed treated in mud and water, is used.

APPENDIX B.

ASSISTANCE IN BRAIRING.

Experiments were carried out by McKinstry with a view to determining the most suitable bean to plant as an aid in breaking the soil crust when planting at wide spacing single seeds from small quantities of valuable cotton-seed. At the same time filling in of the seed holes with sand and sawdust was tried. The beans used were Red and White Canadian Wonder, White Tepary, Woodforde's Dolichos, Sunn Hemp, Munga bean and Soya bean. It was difficult to get really conclusive results.

The seedlings from the small bean, White Tepary, Munga, and Sunn Hemp break through without helping much in breaking the surface crust. Soya bean, White and Red Canadian Wonder, and Dolichos were more satisfactory, and when they were used, better stands were obtained than when they were not used. In the particular set of experiments carried out Dolichos is possibly the most satisfactory of all.

An increased stand was gained by filling in the seed holes with sand instead of with the soil, but a very much poorer stand was obtained when sawdust was used for filling in the holes.

This coming season on the station it is proposed, in planting out strains at wide spacing for multiplication, to fill in the seed holes with powdered kraal manure.

APPENDIX C.

ROTATION CROPS GROWN.

In all, 60 acres were under cotton last season, 74 acres under maize, 6 acres under maize and sweet corn for trap crops and used for ensilage, and $5\frac{1}{2}$ acres under groundnuts.

The mean yield of maize for the station was 10.9 bags per acre, 2,180 lbs. per acre shelled maize. The seed used was Hickory King selected from last year's crop, and the spacing was 3 feet 6 inches by 18 inches. At Salisbury Show, the leading maize show in Rhodesia, cobs grown on the station won four prizes in the Hickory King classes, two firsts and two seconds.

Twelve of the best cobs have been retained for ear to row work this coming season. Each about 8 inches long and true to the Hickory King type, the mean cob weight is 349 grms., the limits being 320 grms. and 367 grms; the mean grain weight is 303 grms., the limits 282 grms. and 328 grms., and the mean core weight 45.6 grms., the limits 35 grms. and 58 grms.

On a block of 45 acres of second year land following cotton, maize was planted with a planter and fertilized at the rate of 150 lbs. per acre of bone and superphosphate. In the middle of the land the planter was allowed to run for one series of rows without fertilizer, for another series with fertilizer, and so on. Four rows the usual land length were considered as a plot, and the arrangement of fertilized and unfertilized series of rows or plots was on the A B B A principle. There were eight replications. In weighing the yields, only the weights from the two middle rows of each plot were taken, it being considered that the two outside rows were influenced to a certain extent by the treatment of their adjoining plot. It is perhaps not strictly exact to use "Student's" method for assessing the significance of the differences obtained with such an arrangement, each "plot" having a 7 feet discarded strip between it and its adjoining one, but the soil was relatively uniform, and that method appeared to be the most satisfactory one to use.

Table XIII. gives a summary of the results obtained.

The conclusion reached is that with the season experienced, on second year land of that description, following cotton, no increased yield of maize was obtained by the application of 150 lbs. per acre bone and superphosphate.

The mean yield of groundnuts obtained was 1,600 lbs. per acre. The variety was Spanish Bunch and the spacing 2 feet 6 inches by

6 inches. Single plants have been selected for progeny row work this coming season. They were selected for the size and shape of the shells and the weight per plant. Ten of the best selected plants gave yields of from 3·5 to 4·5 oz. per plant, mean 3·7 oz., with either three or four nuts to the majority of the shells.

TABLE XIII.
MAIZE FERTILIZER TRIALS—EIGHT REPLICATIONS.

<i>Plots.</i>	<i>Mean Plot Yield Shelled Maize (Lbs.).</i>	<i>Equivalent Yield per Acre Shelled Maize (Lbs.).</i>	<i>Mean Difference (Lbs.).</i>	<i>Equivalent Difference per Acre (Lbs.).</i>	<i>Standard Deviation of Differences (Lbs.).</i>	<i>"Student's" Factor Z.</i>	<i>Significance of Differences.</i>
Fertilized ..	502	1·957	+8	+31	102	0·07	Not significant.
Unfertilized	494	1·926					

In November rows of some hundred wheat and barley varieties obtained from the Department of Agriculture will be planted out with the rains in order to observe throughout the season the incidence of rust attack.

ANGLO-EGYPTIAN SUDAN

REPORT ON THE WORK ON COTTON CARRIED OUT BY THE PLANT-BREEDING SECTION, DEPART- MENT OF AGRICULTURE—SEASON 1926-27*

BY
M. A. BAILEY.

PART I.—INTRODUCTORY.

WORK on cotton has been carried out on the lines indicated in last year's report.

The behaviour of the crop at Shambat was exceptional, and the pickings were so poor in quantity and came in so slowly that the season had to be prolonged right into May, 1927, a circumstance which delayed very considerably the working-up of results, and rendered the preparations for the coming season difficult to carry out in sufficient time.

This feature was not peculiar to Shambat alone, but was shared by all the Government Pumping Stations situated along the Nile at varying distances up to 200 miles north of Khartoum.

The general drop in yield, compared to the previous season, is so striking that the following figures are reproduced in order to illustrate it:

YIELDS AT PUMPING STATIONS IN 1925-26 AND 1926-27 COMPARED. (YIELDS
GIVEN IN LARGE KANTARS† PER FEDDAN.)

					1925-26.	1926-27.
Shambat	..	..	..	..	2.7	1.1
Gendettu	..	..	..	..	5.2	2.6
Kitiab	..	..	..	..	4.5	3.3
Mikeilab	..	..	..	..	4.7	3.3
Bouga	..	..	..	..	3.7	2.1
Nuri	..	..	..	..	5.1	3.8
Gureir	..	..	..	..	3.3	3.2
Ghaba	..	..	..	..	3.9	1.5

This general depression in yield was not shared by the Gezira tract, including the Government Pumping Station at Kamlin, where excellent yields were obtained in all cases. Kamlin is situated at the northern end of the Gezira area, and is relatively close to Shambat.

* May 1, 1926-April 30, 1927.

† A large kantar=315 lbs. of seed cotton.

The results at the Experimental Farm at Shambat have naturally been very disappointing, and the yield of seed from individual plants in the breeding plots has been extremely low in many cases.

The full reason is difficult to arrive at, but it may be taken as certain that exceptionally heavy depredations by the Sudan Bollworm during the early flowering season have been responsible for a considerable part of the loss in some cases at any rate. This would certainly seem to have been the case at Shambat, and reports of severe attacks were also received by the Government Entomologist from some, but not all, of the Pumping Stations concerned.

The possible effects of climate are dealt with a little further on.

STAFF.

The permanent staff of the section has been increased by the provision of a post for an Assistant Plant Breeder. This has been filled by Mr. H. E. King, who was appointed on June 18, 1926. This additional appointment has enabled the very large programme of work which was laid down for the season to be carried out satisfactorily.

In other respects the staff remains as it was last year, except for certain changes in the Sudanese personnel occupying the posts.

During the course of the season the Empire Cotton Growing Corporation decided to attach Mr. F. E. Kenchington, who had just completed a studentship course at Trinidad, to this section for a year's further training. Mr. Kenchington reported for duty on October 2, 1926, and his presence here has enabled the work to be extended in the direction of investigating the actual local conditions under which the plant grows. The work carried out by him is included in the body of the present report.

BUILDINGS AND EQUIPMENT.

The main laboratory and office have been satisfactorily completed, and have been in full use during the season.

The new gin-room and baling-room were completed early, but some delay was experienced in obtaining the necessary equipment.

The baling machine is a small handpress supplied by Messrs. John Shaw and Sons, of Salford, and capable of turning out small bales of from 2 to 10 lbs. weight. After some slight modifications it has produced quite satisfactory results. Baling work started on March 8, but at that time the new season's crop had not yet been ginned out, and only samples from the previous year were dealt with.

The full-sized roller-gin (Single Action Macarthy Gin, supplied

by Messrs. Dobson and Barlow) was installed during March, but owing to delay in the provision of electrical power, ginning could not be started until well after the termination of the period at present under review (actually on June 15).

The delay in this last case was due to a change of policy as to the source of the power supply, but the final decision to connect up Shambat with the main power supply of Khartoum is in every way satisfactory from the point of view of the station, and more than compensates for the delay in getting the gin working this year.

Approval has been given for the erection of a cotton store, consisting of two iron sheds with a concrete seed-sunning floor at the back, and for the building of a suitable range of buildings close to the present laboratory for the accommodation of the Sudanese staff, together with store rooms, etc.

Neither of these buildings has as yet been commenced, and there has been considerable congestion in consequence, during the past winter, both as regards working-room for the staff and as regards storage space for cotton. There is little doubt, however, that both will be finished during the coming season, and when this has been done the development of the section in this direction may be regarded as being very satisfactorily completed.

THE EXPERIMENTAL FARM.

No change has occurred in the area of the farm itself during the present season. Arrangements were, however, made for the renting of two pieces of land in the neighbourhood for the siting of cotton variety test plots. Both of the plots are within three miles of the farm itself, and are worked with the labour and implements belonging to the farm. One of the plots, 5 feddans in extent, is rented from native owners, the water being supplied free by the Government. The other plot of 3 feddans is situated at Kober, and is rented from Mr. Aziz Kfoury, who generously supplies the water free of cost.

Excluding these two plots, which were both entirely under cotton, the cropping of the farm in the present season has been as follows:

Cotton	..	..	..	..	23	feddans	
Dura	..	..	..	..	2 $\frac{1}{2}$	„	(summer 1926 only)
Berseem	..	..	..	..	12	„	
Cowpeas, etc.	..	..	..	..	1	feddan	
Wheat	..	..	..	..	2	feddans	(winter only)
Fallow and Trees	..	..	..	..	49	„	

SOIL AND CLIMATE AT SHAMBAT.

Soil.—Certain observations on the nature of the soil of the Experimental Farm have been made during the season in the course of

investigations on the growth-habit of the root systems of cotton-plants. These observations are confined to four different sites on the farm only, but they tend to confirm the *general* tendency, noted in last year's report, for the surface soil to become progressively heavier as one passes from the top layer down to a certain point, where a more or less abrupt change takes place to an entirely different soil of a much lighter and often decidedly sandy character.

In the present series of observations the surface soil was noted to be heavy and brownish-grey in colour. The texture of the first 10 cms. was satisfactory. Below that the soil became progressively heavier and browner in colour, but appeared to provide a suitable medium for root development until a depth of about 40 cms. had been attained. Here the soil normally assumed a character distinctly unfavourable to root growth. It usually had a bluish tinge, and would be classed as a hard, heavy clay breaking with a short, hard fracture. This layer extended for a variable thickness, roughly between the limits of 30 to 80 cms., after which a more or less sharp transition took place to yellowish-brown, open-textured, sandy loam eminently suitable for root development.

Indications were obtained that between successive irrigations the moisture content of the soil fluctuates widely in the upper layers. This fluctuation appears to become less and less till a point is reached round about 45 cms. below soil level, where the moisture content remains relatively steady at about 18 per cent. It will be noted that this point lies within the "impermeable" layer. As one passes further down through this, the moisture content increases very slowly but steadily until the sandy layer is reached, when the percentage of water rises rapidly.

Climate.—As regards the meteorological conditions which have been experienced during the season under review, rainfall was below normal, and amounted to 70·6 mm. in all (the normal being about 125 mm.). Most of this rain fell on one day, July 31, when over 50 mm. were recorded. The more important plots had been sown about three weeks previous to this, and the young plants were sufficiently well-established and did not appear to suffer.

Observations on temperature and humidity have been kept at Shambat for the past thirteen years, and the data forwarded to the Physical Section of the Ministry of Public Works at Cairo, who have now very kindly supplied us with curves showing the daily normals representing the whole of that period. With the help of these curves it is possible to make the following analysis of the climate during the present cotton season:

	<i>Maximum Temperature.</i>	<i>Minimum Temperature.</i>	<i>Relative Humidity.</i>
1926.			
July ..	Almost consistently above normal to extent of 3° C. on the average	Generally slightly above normal.	Round about normal.
August ..	(43.5° C. recorded on August 22)		
September	About normal	About normal	Below normal (about 10 per cent. down) throughout.
October ..	About 2° C. above normal throughout	Mostly slightly below normal.	Generally much below normal (about 20 per cent. down).
November	First week above normal. Rest below normal, especially from 15th to 20th, when maximum averaged about 5° C. below normal	Normal for first week. Decidedly subnormal from 19th to 23rd (10° C. recorded on 19th); another cold spell occurred from 26th onwards, lowest temperature being 11.5° C.	Generally much below normal (about 20 per cent. down).
December	About normal	About normal except for a rather low temperature on Dec. 1	About normal.
1927.			
January ..	First ten days about normal. Rest of month well above normal (3°-4° on average)	Normal for first three weeks, after which well above normal	First three weeks below normal, last week above.
February	First ten days above normal. Subnormal from Feb. 11-19 to extent of about 2° C.	Normal except for period 14-21, which was decidedly low (7.5° C. on Feb. 15, 7.0° C. on Feb. 16)	Below normal by about 10 per cent.; particularly so during last few days of February and first week of March.
March ..	About normal	Rather cold during first week, otherwise normal	
April ..	Below normal for first half and above during second half	Mostly subnormal	About normal.

The most striking features which emerge from the above are: (1) the unusual highness of the day temperature figures during nearly the whole of the period from sowing to the beginning of picking;

(2) the two cold periods which occurred in the middle of November and the middle of February respectively; and (3) the dryness of the atmosphere during September to November when flowering should have been in full swing, and again during February and March when a large proportion of the bolls were ripening.

This combination of high day temperatures with extreme dryness and occasional short spells of low night temperatures must have constituted an extremely trying environment for the plants, and, combined with the unusually heavy attack of Sudan Bollworm referred to above, might reasonably be considered to account for the observed behaviour of the crop.

PART II.—EXPERIMENTAL WORK, ETC.

(1) INSPECTION OF COTTON AREAS.

Two short tours were made in the course of the present season in the rain-grown cotton area, the districts selected being Fung Province and Nuba Mountains Province.

These tours were undertaken partly in connection with the scheme for the establishment of variety-testing stations, and partly with the object of seeing at first hand the conditions under which cotton is growing in those districts.

(A) *Fung Province*.—This inspection was carried out during the rainy season, and lasted a little over a week.

By the courtesy of the Governor of Fung Province, I was allowed to make use of the Province steamer, travelling slowly upstream from Makwar to Roseires, and stopping at any places on the way which appeared to be of interest from the cotton point of view. The region traversed included three districts (“merkaz”)—namely, Singa, Karkoj, and Roseires. I was able before starting to obtain some figures showing the quantities of cotton seed which had been distributed in these districts during the past two seasons.

The rains of the previous season had been very light, and in consequence there was a shortage of food, the effect of which was shown in the decreased demands for cotton seed. This lack of interest on the part of the natives was also due no doubt to the fact that in many cases in the previous year cotton had been sown in places where, with the low rainfall experienced, the plants withered at an early stage, producing little or no crop.

In Singa “merkaz” some 250 sacks of seed had been used as

against about three times this amount in the previous season; in Karkoj 450 bags had been taken up, about 150 less than in 1925, and in the Roseires district the demand this year had been practically nil. In this last district the District Commissioner was impressed with the necessity for increased food production, and this point of view was doubtless reflected in the area under cotton. In this last district also, it appears that a considerable amount of the cotton which is grown goes over the border to Abyssinia, where it is bought by small native merchants.

Taking the whole area from Sheikh Talha (near Makwar) in the north to Roseires in the south, one finds a steady increase in yearly rainfall from 500 mm. to nearly 800 mm., practically the whole of this falling within the months April to November. The remainder of the year is occupied by a true dry season, when all vegetation dries up and the grass is mostly burnt off.

Practically the whole of the cotton is grown on the black cotton soil, which requires a considerable amount of rain at the beginning of the season in order to put it into a fit condition for the sowing of the cotton. In the dry season this soil bakes out, and becomes excessively hard, with enormous cracks. The baking is, however, beneficial, and it is surprising to observe the loose fine tilth which is obtained after a few heavy showers and without the help of any cultivation. This good working condition is lost as the season progresses and the soil receives more water.

Allowing for this preparatory phase, sowing is usually possible during early to mid-July, and is generally done about that time, which means that the opening of the crop coincides pretty well with the onset of the dry season.

For the most part, the ground rises fairly rapidly on either side of the river for a distance of a mile or less, beyond which it stretches out in a more or less level plain. The level plain is formed by the black cotton soil and the rising ground of the riverside by a light-coloured nodular deposit known locally as "Azaza," which is useless for cotton-growing. In places the cotton soil only reaches a sufficient depth for cultivation at a distance of several miles from the river, the intervening space being filled with trees which become larger and more varied as the rainfall increases. In other places the cotton soil comes right up to the water's edge and may at times be seen in section in the "cliff" where the river is cutting back into the bank.

From the river very little cotton is seen, and the bulk of it is, in fact, grown right inland, sometimes as far as ten to twenty

miles away from the river. The same remarks apply to the Dura crop, which is grown on similar soil and under similar conditions. Several excursions were made into the fringe of this back-country, which, when reached, is all more or less of the same type. More attention was, however, paid to the areas where the cotton soil reached the river's edge. In such places it is usual to find a large cleared area lying just behind the village which is on the bank of the river. Such areas were found at Karkoj, Abu Naama, and Sabonabi-es-sherig. They offer suitable sites for variety tests, as they can be reached from the river at any time during the rains, and present the typical black cotton-soil conditions of growth. The three areas specified appear to be kept more or less permanently clear of big bush, whilst in the hinterland and in other smaller areas encountered near the river bank it appears to be the custom to clear a piece of land, and, after four or five years, to move on to a new site, allowing the first piece to go back to its original condition. At one such place (Shamea Khalil) I was interested to find that the natives regarded the appearance in abundance of a certain weed (*Sonchus sp.*) as a signal to move on to a new pitch.

I have no doubt that a study of the local flora in relation to the suitability of the land for cotton cultivation would yield valuable results applicable to the development of new areas. The major soil differences in the more southerly area were clearly marked by the changing tree-flora, the final transition to the true black cotton soil being almost always accompanied by the dropping out of all trees except the Talha (*Acacia seyal*).

The neighbourhood of Sabonabi-es-sherig was finally selected as a site for two cotton variety tests in the coming season. Here the cotton soil comes right up to the water's edge, and a natural "section" occurs in the cliff-face, which enables one to form an extremely good idea of the subsoil conditions. Photographs of this section were made and soil samples taken. The black cotton soil in this place is typical, but is somewhat lighter than in several other localities, thus favouring the obtaining of a regular stand of plants, so essential in variety-testing work. Sabonabi is about thirty miles south of Karkoj, and the rainfall is in the neighbourhood of 650 mm. and fairly reliable, as evidenced by the growth of "elephant grass," which here begins to reach a fair height, though practically absent at Karkoj and further north.

The following are typical analyses of "black cotton soils" (the actual samples were taken at two places near Singa, and represent the first foot of soil):

Place.	Stones and Gravel.	Coarse Sand.	Fine Sand.	Silt.	Clay.	Salts.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Radina ..	0.7	7.6	13.2	11.9	66.4	.091
Hillet Assar ..	0.0	4.4	10.8	12.4	72.5	.095

At Galgani, a village about ten miles south of Sabonabi, cotton was found growing under conditions quite different from those described above. Here an area of flat "gerf-land," consisting of sandy alluvium of comparatively recent origin, fills a bend of the river. The surface of this flat plain of about 500 acres lies only a few feet above the high-water level of the Nile, and behind it, at a distance of half a mile or so, rises the old bank of the river composed of the typical "Azaza" soil. The population of the village consists almost entirely of West Africans who have settled here either temporarily or permanently in the course of the pilgrimage to Mecca. Their cotton is grown almost entirely on the gerf-land referred to, and is able to draw on subterranean water supplies in addition to the normal precipitation. Sowing had been carried out about two weeks earlier than could be done on the "cotton soil," and the plants when seen were about 35 cms. high, and had for the most part unfolded their eleventh or twelfth leaf. They appeared healthy and quite unaffected by scorching, so prevalent further north. The usual insect and other diseases, including Blackarm, were present, but were not serious. Bud-shedding had taken place to a rather considerable extent, but I understand that useful crops had been obtained in the previous season. It would seem that very good yields might be achieved if the natives gave more attention to cultivation. The plots were for the most part choked with weeds, and thinning of the plants had generally been neglected. It would seem that this type of cultivation might be considerably extended in these regions, as it has the great advantage, as far as cotton is concerned, of ease of transport, and is at the same time partially independent of a somewhat uncertain rainfall. The disadvantages are the excessive growth of weeds and the fact that much of this land is covered with a type of thorny bush (*Zizyphus*) which spreads underground and is extremely difficult to eradicate.

The only competitor in the way of crops is maize, which, when sown early in these situations, produces a good return before the main Dura crops in the inner regions have ripened. This early crop of maize is often very valuable in helping the population to tide over

until the new crop of Dura is ready, but it cannot be denied that this same object could be achieved if the areas of black cotton soil placed under Dura were increased, as could well be done with the present population, given the incentive to a little more industry. In the Roseires district practically the whole of this type of land was under maize, but further north only about one-fifth of the area appeared to be so used.

I attempted to make a very rough estimate of the extent of this gerf-land between Disa in the south and Karkoj in the north, a distance of about ninety miles along the river. Speaking very roughly, there appeared to be something like 10,000 feddans of gerf-land, of which about 3,000 feddans was thickly covered with bush and about 2,000 planted with maize. The remainder, say 5,000 feddans, appeared to be capable of cultivation under cotton, or other crops, without diminishing the present food area. It is probable, however that this area would have to be considerably reduced owing to the landward side of these stretches usually lying low, and in many cases actually filling with infiltration water. Some of the individual areas were large, but generally the cultivable area at each spot appeared to be about 200 or 300 feddans. The largest (estimated) single areas were south of Abu Kuk (say 700 feddans), opposite Abu Zor (say 500 feddans), and opposite Meshra el Khallak (about 700 feddans).

(B) *Nuba Mountains Province*.—This is a most promising district for the development of rain-grown cotton, and has been rightly favoured by the Department of Agriculture and Forests in their schemes for the development of cotton-growing. General accounts of the conditions and of the system employed have already been published, so that only a very brief description will be given here.

In general, it may be said that the area consists of an immense plain, composed largely of black cotton soil, from which, like islands emerging from the sea, arise large mountain masses of granite or sedimentary rocks. Around these "islands" spread gently sloping expanses of rock detritus, often for a width of many miles. Frequently, neighbouring mountain blocks are connected either by the confluence of their talus slopes or by low ridges of partially weathered rock. Some of the narrow valleys opening out from the foot of the mountain masses are filled to considerable depth with river-silt. The soil conditions are therefore extremely varied, and it is interesting to find cotton growing and yielding good crops in all these different situations.

The factors of most importance in determining the best cotton-growing areas would appear to be:

(1) A sufficiency of water. Most of the southern part of the district averages about 750 mm. in the year, and is sufficiently well supplied, but a large portion of the northern area does not receive enough to allow of any certainty of obtaining a useful crop in a normal year.

(2) Absence of flooding. Large tracts of the low-lying cotton soil are liable to be permanently under water for two or three months on end.

(3) Absence of undue surface erosion. In many places the heaviness of the individual rain-storms, combined with the steady slope of the land, causes the water to flow over the surface, scouring away the soil as it goes and washing out the growing plants. One of the cotton variety test plots met this fate during the season under consideration, resulting in a loss of about seven-eighths of the crop.

(4) A soil capable of holding water and reasonably penetrable by roots. Apart from this, the actual composition of the soil appeared to be of little importance, and excellent fields were seen both on heavy black cotton soil and on light sandy soils. A reddish-coloured loam containing a fair proportion of gritty sand appeared to be about the ideal where other conditions were suitable.

The trees and other natural vegetation appeared to act as a more or less reliable index of the nature of the soil.

The following is a selection from some soil analyses made for me by the Government Chemist on samples collected in the various areas, and the differences shown are very striking:

<i>Sample No.</i>	<i>Stones and Gravel.</i>	<i>Coarse Sand.</i>	<i>Fine Sand.</i>	<i>Silt.</i>	<i>Clay.</i>	<i>Notes.</i>
J. ..	% 26.4	% 47.6	% 14.7	% 5.9	% 5.3	"Gardoud" soil taken from a sloping field right at the foot of a mountain and made up of detritus washed from it. Cotton was excellent.
L. ..	0.0	3.9	11.4	21.4	63.3	Typical dark brown "cotton soil" capable of producing well-grown plants and a satisfactory crop.
M. ..	0.0	2.6	30.6	26.4	40.7	From a field near Kadugli, bearing a very good crop of cotton; reddish in colour with some largish cracks, but much less than in "cotton soil."

My visit to this district was made at the beginning of the third week in November, and lasted about ten days, during which I was able to travel by motor-lorry through the most important cotton-growing areas. The actual itinerary was: Rahad, Rashad, Delami, Heiban, Talodi, Kadugli, Dilling, el Obeid.

No really successful attempts at cotton-growing were seen until Heiban was reached, but excellent fields were seen there and between it and Talodi. At Talodi a detailed inspection was made of a cotton variety test which had been carried out for us by the Inspector of Agriculture. This particular plot was a great success, as far as regularity and growth of the plants were concerned. The most important cotton area is, however, situated round Kadugli as a centre, and here I was able to see several fields of very well-grown cotton. Under suitable conditions the plants had grown extremely well, and only in rare cases was rank over-growth noted. Shedding was as a rule comparatively slight. The normal spacing appeared to be rather wide, and I think somewhat better results would be obtained if the natives could be induced to sow closer. Sowing was formerly carried out rather late, largely with the idea of bringing the whole of the picking season into the dry period of the year. It has been observed, however, that by planting earlier it is possible to escape a portion of the Stainer-bug (*Dysdercus*) infestation, and late June is now considered the best period. An inspection of the rainfall data suggests that this should be about the ideal time, allowing, on the one hand, for the soil to become sufficiently moistened and the first crop of weeds to be cut out, and, on the other, for the bulk of the boll-opening to occur in the dry season, which starts about early November and lasts until about the end of March. An argument for July sowing, however, exists in the occurrence of a comparatively drier spell at that time, enabling sowing to be done in a better manner, and possibly reducing the risk of Black-arm infection.

American-type cotton is at present exclusively grown, and this would certainly appear to be the preferable type in view of the extra susceptibility of Sakel cotton to Black-arm disease, and the slowness of arrival of the crop due to its tendency to "miss-fire" in the lower part of the fruiting-branch zone. The more drawn-out character of the picking period in the case of Sakel would probably result in the loss of a large portion of the latter end of the crop from water-starvation. The seed used is supplied from the Government Pumping Stations on the Nile, and though the yield is satisfactory, the quality and purity of the crop leave much to be desired. The

irregularity in habit of the plants gave plenty of opportunity of selection of types apparently suited to the conditions, and several such selections were made. In general, stems and branches tended to be rather thinner and internodes longer than under conditions of irrigation, and monopodial branching was considerably less abundant. The differences between individual plants appeared to be accentuated here, both as regards vegetative habit and lint characters. Pests were not seen in excessive quantity, but a fair amount of damage to early buds and flowers had been caused by the Sudan Bollworm, followed by the "American Bollworm" (*Heliothis obsoleta*).

Throughout the whole journey observations were made on the state of growth of the plants, and full details entered as to the areas of the different types of soil encountered *en route*, together with a few notes on the trees associated with them.

At Talodi I was met by Mr. G. F. March, to whom the development of this area has been entrusted. From him I obtained details as to the quantities of seed issued and the methods employed for collecting, taking-over, and transporting the cotton. The undertaking has been extremely successful, and the yield from this season's crop amounted to nearly 9,000 large kantars, although a start was only made three years ago. The population is very backward judged by ordinary standards, but has responded very well to the encouragement given. The inhabitants may be expected to make quite efficient cultivators of their class, and, given time and immunity from raids, should soon spread downwards from the hills into the many large and extremely promising areas which lie some distance from the mountains. There is, without any doubt, a very large area of suitable ground awaiting future development.

(C) *The Gezira Area*.—As usual, two or three visits were made during the course of the season to the Gezira Research Farm and the Seed Farm of the Sudan Plantations Syndicate. The primary object of these visits was the making of records on the two cotton variety test plots situated at those places, but the opportunity was taken to examine some of the surrounding cotton areas at the same time. One extremely interesting feature was noted, and that was the entirely different behaviour of the cotton on the Gezira Research Farm, compared with the previous year and with former experience in the Gezira area.

The difference lay in the fact that the phenomenon of suppression of the lower fruiting branches was practically absent. Effective fruiting branches were commonly produced in the tenth or eleventh leaf axil of the stem, as against the twelfth to fourteenth axil in the previous

season's crop. This effect was shared by *all* the cotton plots on the Gezira Research Farm, and by *all* varieties (in different degrees) in those plots. The change would not have been considered very remarkable, if it had not been noted that the plants at the adjoining Barakat Seed Farm did not show it. The behaviour there was that of the normal Gezira type noted in last year's report, fruiting branches being produced in the thirteenth to fifteenth axils, or even higher. An examination of the cotton in the neighbouring areas showed that it agreed with the normal Barakat type.

The improvement in appearance of the crop at the Research Farm was very striking, the usual "legginess" being practically absent. This improvement was accompanied by a very much improved yield, and by an entirely different manner of "arrival" of the crop as compared with Barakat.

The variety test plots at these two places agreed entirely with the crops surrounding them, and as they each contained exactly the same series of varieties grown from the same seed and sown on practically the same day, the observations made on them are particularly valuable for comparative purposes.

The first picking at the Research Farm was taken over three weeks earlier, and another quite large picking was made before any cotton had been gathered at Barakat. The third picking at Wad Medani Research Farm was easily the largest, good-sized yields being obtained also from the fourth and fifth pickings. At Barakat the earlier pickings (already late in time of arrival as compared with Wad Medani) were comparatively small, and big pickings were not taken until the fifth and sixth pickings, at a time when the Medani crop was nearly finished.

Only about one-twentieth of the Medani crop was picked in the month of April, whereas nearly a quarter of the whole crop was taken in that month in the case of Barakat, where the plants were of the usual leggy type and lodged badly during the later pickings. The reasons for this difference in behaviour are being investigated, and it is hoped to publish the results at a later date, but it would seem probable that they are connected with the presumably higher moisture content of the soil at Wad Medani, brought about by an extra watering given in the early stages and conserved by more frequent surface-tillage, or possibly by a lower soil temperature or air temperature induced by these waterings. The matter is certainly one of the highest importance to the future of cotton-growing in the Gezira.

Another point of considerable importance was noted in con-

nection with a test which was carried out this season at the Gezira Research Farm between different strains of cotton. Sakel strains from Tokar and Kassala were included this year as last, and observations were made in both years on the relative vigour of the various strains when in the earlier stages of growth. The records in both cases were made "blind" without any key to the individual subplots, and the results have been sufficiently consistent to suggest that they have some significance. In the previous year the subplots sown with Sakel seed from Tokar and from Kassala were evidently the most vigorous: in the present season strains from these places were clearly surpassed in vigour by other strains, including locally grown seed. The reason for this difference is doubtless connected with the fact that both the Tokar and Kassala seed which were supplied this year for the test were immensely superior in the matter of purity to that of the previous year. The apparent extra vigour of the previous year was certainly due, in part at any rate, to the very large percentage of hybrid plants.

(2) COTTON VARIETY TESTING.

The scheme referred to in Appendix B. of last year's report has been put into effect, and the results obtained appear to be sufficiently satisfactory. I have attached great importance to this side of the work, as I feel convinced that it is waste of time attempting to produce new varieties if we have not the means of deciding whether, when produced, they are an improvement on existing ones. Even in cases where breeding has been carried out with one particular object in view, and that object achieved, it is impossible to say without trial whether the rest of the genetic constitution of the plant has not been altered in some direction which will be actually deleterious as regards yield.

The technique of variety testing in general is beginning to be understood, and it is now usual to make use of the standard error of the differences between varieties in deciding the degree of reliability of the results obtained. It cannot, however, be too strongly emphasized that these mathematical criteria are based on the law of chance working within a large population. In the case of variety tests, repetitions of each of the types in different parts of the field are essential if any useful results are to be obtained, but it is impossible in practice to work with such a number of repetitions as will be sufficient to avoid absolutely the danger of a misleading value being obtained. Furthermore, results which are apparently statistically significant

in one plot may be contradicted by those obtained from another plot. Yield figures alone will be of little assistance in helping us to decide in this case which of the varieties is most likely in general to succeed.

With these considerations in view, an attempt has been made to keep a *developmental record* of the plants in the variety tests, in order that some information may be available to act as a check on the accuracy of results obtained, and to assist in explaining the differences noted. This work takes up a very considerable amount of time, both in the collection of the data and in the process of working up the results, but it is so important that no excuse need be made for embarking upon it. At the present time practically no information is available to cotton workers as to the connection between the various developmental characters and the final yield, so that it remains to be seen how far this line of research will yield the information hoped for.

The area in which cotton is grown in the Sudan is a very extensive one, and the conditions of soil and climate under which the plants live cover a very wide range. It has therefore been necessary to establish a *series* of testing stations in different parts of the country in order to gain information as to the behaviour of the varieties under the varying conditions. The distance between these plots and the slowness of transport makes the taking of developmental records additionally difficult, and the impossibility of supervising picking operations in two places at the same time necessitates that the layout of the plots should be as simple as possible.

The final scheme adopted, therefore, is in the nature of a compromise between full accuracy of the individual plot and wideness of applicability of the results obtained. The tests are divided into two series, one being concerned with *Egyptian-type* cottons grown under conditions of irrigation, and the other with *American-type* cottons under both irrigation and rainfall conditions. In each series a standard layout was adopted with subplots of similar size and shape, and the varieties tested were the same in each case.

The number of varieties tested in the more easily controlled Egyptian cotton areas was six, the total area of the plots being 5 feddans, but in the case of the American tests, some of which had to be carried out in places far removed from railways and quick transport, the number of varieties has been restricted to five. In the case of the more accessible American variety plots situated in the northern irrigation zone, the area of each plot has been fixed at 5 feddans, but that of the distant plots in the rain-grown areas has been kept down to 3 feddans only.

The number and arrangement of the test plots carried out this year are as follows:

(A) EGYPTIAN VARIETIES.—(1) *A single plot* at Shambat, situated in the general cultivated area, not far from the Experimental Farm.

(2) *A single plot* at Wad Medani, carried out by the Chief Inspector, Gezira Research Farm, on their land.

(3) *A single plot* at Barakat, carried out on the Seed Farm of the Sudan Plantations Syndicate by the Manager of the Seed Farm.

(B) AMERICAN VARIETIES.—(1) *A single plot* at Kober, on the estate of M. Aziz Kfourri, situated about three miles from the Experimental Farm at Shambat (irrigated).

(2) *A pair of plots* near Shendi, on land belonging to the Government Pumping Station at Gendettu (irrigated).

(3) *A pair of plots* near Singa, carried out under arrangements made by the Inspector of Agriculture, Makwar, on land rented from native cultivators (rain-grown).

(4) *A pair of plots* near Talodi, carried out by the Inspector of Agriculture, Talodi, on land rented from native cultivators (rain-grown).

The actual situation of these ten plots, and their relation to the surrounding cotton areas which they represent, as well as to the distribution of rainfall, can be gathered from an inspection of the accompanying sketch map.

It is not proposed to enter into details with regard to the arrangements made for the carrying out of agricultural operations, including picking, etc., but hearty thanks are due to all those outside the Plant Breeding Section who have assisted in the work.

In the case of the plots at Wad Medani and Barakat the ginning of the seed cotton has been carried out locally under arrangements made by the officials in charge of those stations: in all other cases the seed cotton has been transported to Shambat, and ginned out by the Plant Breeding Section at its own ginnery. In all cases any seed cotton taken from the plots for sampling purposes has been ginned out at Shambat for the sake of uniformity. As regards the plots themselves, these are in all cases rectangular in shape, and about three to four times as long as broad. Each plot is divided into five portions, and each of these five "blocks" is itself divided into a number of long, narrow strips which constitute the individual beds sown with the different varieties. All the varieties are represented in each of the five blocks, but the order in which they occur in the strips making up those blocks is different in every case, thus

minimizing errors due to progressive changes in fertility across the field.

In those plots where five varieties are being tested five times, the varieties are so arranged that no variety occupies the same relative position within the block more than once.

It is not claimed that this arrangement of varieties in long narrow strips will give results which are any more accurate than those obtained from the conventional chequer-plot, but it is claimed that the accuracy will be practically the same, whilst the simplification in all respects as regards laying out, sowing, and picking will be very great, and purely accidental errors will thus tend to be eliminated.

As regards accuracy, it stands to reason that when two adjacent plots, long and very narrow in shape, are being compared, the comparison will be very much closer than when two adjacent beds of the same area, but square in shape, are used. The narrowness of the strips means that the centre-lines of the two beds are very close together, and the length means that each bed will tap a considerable number of different soil patches, giving a steadier average result per bed as a consequence. This is borne out by results previously obtained by Mr. Trought and myself in Egypt, where it was found that the standard error of a single plot of cotton of long narrow shape was less than that of a single plot of square shape. The same series of experiments indicated that the best results should be obtained by making the area of each subplot between $\frac{1}{10}$ th and $\frac{1}{8}$ th feddan. The areas actually employed in the different series in the present case varied from $\frac{1}{8}$ th to $\frac{1}{7}$ th feddan, but were kept constant within those series.

As regards developmental observations the following list indicates the type of records made in the more accessible plots. The significance of these records and the special methods employed for obtaining them will not be gone into in detail in this report, as it is hoped to publish a separate paper dealing with this subject, if the results obtained appear to warrant it.

ENVIRONMENTAL AND DEVELOPMENTAL RECORDS IN COTTON VARIETY TESTS.

1. *Soil conditions*, as indicated by samples taken from every subplot and analyzed by the Government chemist.

2. *Germination*—record of blank spaces, etc.

3. *Resowing*—amount of seed used in each bed.

4. *Final stand*—an actual count of plants.

5. *Weediness*.

6. *Early and late vigour*.

7. *Early height and final height*.

8. *Rate of node production on main stem and along branches*.

9. *Position on stem of lowest part of fruiting zone.*
10. *Shedding.*
11. *Flower-production.*
12. *Incidence of pests of all kinds, including Black Arm disease.*
13. *Serial yield records*—the final yield being composed of from seven to nine separate pickings.

RESULTS FROM EGYPTIAN VARIETY TEST SERIES.

Unlike the American Variety Series, which, as will be seen later, gave very similar results in each of the localities where the crop had been grown under irrigation, the results in the present series are very conflicting.

All three plots (Shambat, Wad Medani, and Barakat) were sown on almost exactly the same date (August 14th to 18th), and efforts were made to keep the layout and arrangement of the plots as nearly as possible identical. Owing to a misunderstanding, the relative position of the variety beds in the Wad Medani plot was different from that at the other two places.

The marked difference between the neighbouring plots at Wad Medani and Barakat in the matter of arrival of the crop has already been dealt with under the heading of "The Gezira" (p. 147).

The plot at Shambat agreed with that at Barakat as regards the date of the first picking, but the pickings throughout were low and the final yield very poor. (See Introductory Notes on pp. 134-135.)

The relative position of the varieties in order of yield in individual pickings shows great instability in the three plots, and the final results are almost equally discordant.

In the table on p. 153 the varieties in each plot are shown in descending order of merit as regards yield, together with their mean bed yields and standard error of mean difference.

(The standard error for Barakat has not been included owing to the extra irregularity shown by the soil in this plot.)

It will be seen that in all cases the varieties stand very close together in the matter of mean yield per bed, and comparison with the standard errors of mean difference will show that even the two extremes in each case do not lie sufficiently far apart to be "significant."

Notwithstanding this, it may be possible to come to a few general conclusions.

SHAMBAT.—Here the stand of plants was rather irregular, and one bed of Sakel B/24 showed very poor germination indeed. The effect is clearly discernible in the yields of the first two pickings.

A detailed examination of the distribution of individual bed-yields

in space and time (method of working too lengthy for description here) shows, however, that the effects of this irregular germination and of soil balance out pretty closely in the long run as between varieties. The only exception would appear to be Nahdah, which has perhaps gained 2 to 4 rottles in mean bed value through the agency of such external factors. If this very speculative correction be applied it would only have the effect of bringing Nahdah and Bolland Sakel 8 closer together, the order of the rest remaining unchanged.

EGYPTIAN VARIETY TEST SERIES.

SHAMBAT.		BARAKAT.		WAD MEDANI.	
<i>Yield per Feddan for Plot = 1.5 Large Kantars.</i>		<i>Yield per Feddan for Plot = 4.05 Large Kantars.</i>		<i>Yield per Feddan for Plot = 4.2 Large Kantars.</i>	
<i>Varieties.</i>	<i>Mean Bed Yield.</i>	<i>Varieties.</i>	<i>Mean Bed Yield.</i>	<i>Varieties.</i>	<i>Mean Bed Yield.</i>
	<i>Rottles.</i>		<i>Rottles.</i>		<i>Rottles.</i>
Nahdah ..	85.6	Sakel 186 ..	222.0	Sakel 186 ..	242.0
Bolland Sakel 8	83.1	Bolland Sakel 8	217.8	Main Crop Sakel	225.2
M a s s e y ' s	81.9	M a s s e y ' s	217.6	M a s s e y ' s	223.8
Domains Sakel		Domains Sakel		Domains Sakel	
Main Crop Sakel	77.1	Sakel B, 24 ..	213.2	Sakel B, 24 ..	222.4
Sakel B/24 ..	77.0	Main Crop Sakel	208.2	Bolland Sakel 8	213.2
Sakel 186 ..	76.6	Nahdah ..	198.6	Nahdah ..	212.0
Standard error of mean dif- ference = 2.72		Standard error of mean dif- ference = —		Standard error of mean dif- ference = 11.371	

BARAKAT.—In this plot the state of affairs as regards the incidence of accidental factors affecting regularity was much less satisfactory.

Two large patches of specially strong growth occurred, but were fortunately nearly limited to whole "blocks" in each case. The effect was not, of course, equally intense all over these patches, and this fact, combined with the existence of smaller irregularities (one affecting three beds), has produced "accidental" differences between the plots, which do not appear to balance out very well. An investigation of the data suggests that these accidental errors might be estimated (very approximately) as causing the mean values obtained to vary by the following amount from the true values :

Massey's Domains Sakel affected adversely to extent of, say, 4 rottles on mean value.

Bolland's Sakel 8 affected adversely to extent of, say, 3 rottles on mean value.

Gezira Main Crop affected adversely to extent of, say, 2 rottles on mean value.

Sakel B/24 affected adversely to extent of, say, 1 rottle on mean value.

Sakel 186 affected favourably to extent of, say, 1 rottle on mean value.

These corrections, if justified, would put Sakel 186, Bolland Sakel 8, and Massey's Domains at almost exactly the same level. Sakel B/24 and Main Crop would be bracketed together at a slightly lower figure, and the position of Nahdah would remain unchanged.

It may be noted that the above-suggested corrections allow also (very roughly) for the estimated effect of irregularity of stand of plants in the different beds. Irregularities in stand produced a quite clearly marked effect on the yields obtained during the second to fifth pickings in this plot.

WAD MEDANI.—The stand here was fairly satisfactory. The plot was rather clearly divided into an area of high vigour (Beds 2 to 15) and an area of low vigour (Beds 17 to 31, decreasing rapidly in the last few beds). Despite this, irregularities appear to have balanced out very satisfactorily on the whole, though Massey's 186 and Main Crop Gezira may both have been penalized to the extent of not more than one rottle off their mean yields.

It will be seen that the application in this way of "corrections" to the three plots has done little to assist in placing the varieties in their correct order of merit, and it may be taken that they do in fact show no very important difference in the matter of yield. A guess may perhaps be hazarded that Sakel B/24 and Main-Crop Gezira are rather on the low side as regards yielding power, whereas Bolland Sakel 8 and Massey's Domains tend to be higher. As regards Nahdah and Sakel 186, it seems likely that, under the better environmental conditions obtaining at Wad Medani and Barakat, Sakel 186 is capable of setting a bigger crop than any of the others, whereas Nahdah is the worst. Nahdah, however, may be postulated to have a better defensive organization, and under the adverse conditions experienced at Shambat the position is reversed.

A point of particular importance which emerged from our data was the relative susceptibility of the different varieties to *Blackarm*. The six varieties showed the same order at each of the three stations, and we are therefore able to make the following statement with considerable confidence:

Least susceptible	Nahdah.
Next least	{ Bolland 8. Main Crop (Gezira). Sakel 186.
More susceptible	Massey's Domains.
Most susceptible	Sakel B/24.

This information, combined with the indication obtained of low yielding power, suggests that Sakel B/24 should not be used for wide-spread propagation in the Gezira area. Massey's Domains, being also on the susceptible side, should be tried only with caution in areas subject to the disease. It may perhaps be remarked that the attack in this particular year was relatively light all round, and our yield curves appear to show no differential effect due to this cause. The following further general characters would also appear to be established for the varieties examined:

Nahdah.—Rather lacking in vigour, and the rate of node production in early stages is slow. The bottom of the fruiting branch zone is definitely nearer the ground (by about two nodes) than is the case with the other varieties. The earliness which this latter characteristic might be expected to produce is considerably offset by the slow rate of node production. Nahdah lodges worse than any of the other types tried.

Sakel 186.—Rather lacks vigour. Tends to produce rather good early pickings, due probably to a quick rate of node production in the early stages, and to a tendency to put out its fruiting branches at rather earlier nodes than in the other Sakels tried. Growth of monopodial branches is moderate in quantity. The variety is quite satisfactory as regards lodging.

Massey's Domains Sakel.—This type is more vigorous than the foregoing, but it tends to be latish in the matter of production of fruiting branches, a fault which is probably offset by a fairly rapid rate of nodal development in the early stages. Some indications were obtained that shedding was less pronounced in this variety than in some. A slight tendency to show resistance to Thrips and Flea Beetle was noticed at one place. Growth of monopodial branches tends to be slight. This type gave a good average yield in all three localities, and would be satisfactory if it were not for its apparent tendency towards susceptibility to Blackarm.

Sakel B/24 appears to be naturally rather lacking in vigour, and, as previously stated, would certainly seem to be more susceptible to Blackarm than any other of the varieties tried. Its yield is on the low side in all places, and if the trials in the coming season confirm these tendencies it will be abandoned. Early node production is rather rapid, and the first sympodial branch is usually borne at a somewhat lower node than in the average Sakel in this country. It appears to be rather susceptible to Thrips and Flea Beetle. Considerable variation was shown between the different plots in the matter of both monopodial branch production and degree of liability to lodging.

Bolland Sakel 8.—This is the most vigorous growing of the types tried. Nodes are laid down rapidly in the early stages, but the first fruiting branches generally appear late and high up on the stem. On the whole, the variety seems to show indications of some slight power of resistance to Thrips attack, and this, combined with its comparatively low susceptibility to Blackarm, might make it a useful standby in regions where these pests are serious. The variety was satisfactory on the whole as regards lodging. Degree of production of monopodial branches is variable, but usually on the light side.

Main Crop.—This type, which came from seed supplied by the Sudan Plantations Syndicate from the crop grown in 1925–26 at Wad Sulfab, was included in the series for comparative purposes. In yield it occupied a more or less average position at each of the three places. It showed considerable natural vigour and rather rapid early node production, but was definitely unsatisfactory in the delay shown in producing fruiting branches, and appeared to shed rather heavily. It produces rather too much early monopodial branching, and has a decided tendency to lodge badly. It is fairly susceptible to Blackarm, but is perhaps slightly resistant to Thrips.

All the above varieties will be tried again in the coming year, and arrangements are being made for spinning and grading tests and measurements, the results of which are needed for consideration at the same time as the yield figures, in order to make it possible to form some idea of the relative *value* of the varieties to the grower.

RESULTS FROM AMERICAN VARIETY TEST SERIES.

Only four out of the seven plots laid down gave results worth recording. The other three were all situated in areas where they were dependent upon rainfall only for their water supply. Two of these latter plots, situated near Singa, never received enough rain to produce a crop, whilst the third, one of a pair near Talodi in the Nuba Mountains, received so much that practically half the plants were washed out.

Of the four surviving plots, one was situated at Kober, two others near Shendi, and the fourth near Talodi, where it escaped the fate of its companion plot. The results are tabulated on page 157, the varieties in each case being shown in order of merit as regards yield.

Compared with their standard errors of mean difference, the mean bed yields barely show different disparity to enable any except the two extreme varieties in each case to be considered as “significantly” different from the statistician’s viewpoint.

AMERICAN VARIETY TEST SERIES

IRRIGATED PLOTS.				RAIN-GROWN PLOT.	
KOBEL.		SHENDI (PLOT I.).		TALODI.	
<i>Yield per Feddan=2.8 Kantars (Large).</i>		<i>Yield per Feddan=2.6 Kantars (Large).</i>		<i>Yield per Feddan=2.1 Kantars (Large).</i>	
<i>Varieties.</i>	<i>Mean Bed Yield.</i>	<i>Varieties.</i>	<i>Mean Bed Yield.</i>	<i>Varieties.</i>	<i>Mean Bed Yield.</i>
Pump Scheme Strain Pedigree Dixie .. Massey's Selected Gendettu Webber 38 Delta Webber No. 1	<i>Rotilles.</i> 205.5 189.8 182.8 155.6 149.1	Pump Scheme Strain Webber 38 Massey's Selected Gendettu Pedigree Dixie .. Delta Webber No. 1	<i>Rotilles.</i> 190.1 173.0 168.5 152.4 149.5	Pump Scheme Strain Pedigree Dixie .. Webber 38 Massey's Selected Gendettu Delta Webber No. 1	<i>Rotilles.</i> 209.1 206.7 194.4 185.0 170.3
Standard error of mean difference = 23.92		Standard error of mean difference = 10.9		Standard error of mean difference = 3.62	

NOTE.—Of the two plots at Shendi, Plot I. was sited on typical lightish alluvial soil of comparatively recent origin underlain by a sandy stratum, whilst Plot II. was on a type of soil known locally as "Karu," containing about the same proportion of clay in the upper layers, but much heavier to work and only *gradually* passing to a lighter soil below.

The Kober plot was situated on soil very similar to that of Shendi (Plot II.).

The rain-grown plot at Talodi was sited on a rather heavy loamy soil, overlying a lighter subsoil composed largely of decomposed granite.

The three plots grown under conditions of irrigation, however, all show a close resemblance between themselves, in the order of yield of the varieties, sufficient to enable one to form a very fair idea of their relative yielding power under the conditions obtaining for the year in question. This resemblance between the plots is not confined to the final yields, but can be traced to some extent at any rate in the partial yields given at different stages of the picking season, a fact which affords further evidence for considering that it is not merely fortuitous.

As regards the plots themselves, that at Kober suffered considerably in the matter of irregularity of watering, due to mechanical trouble with the pump at that place. This is probably reflected in the greater range of variation in yields shown by individual varieties.

Germination and stand of plants were reasonably regular, but the irregularities which did occur would appear to have affected the final yields to some extent. It would seem that the varieties Delta Webber and Massey's Gendettu may have been slightly penalized by comparatively poor stand. The same two varieties, and also to a less extent Pump Scheme Strain, were probably rather unduly adversely affected by the irrigation difficulties referred to above.

SHENDI (PLOT I.) showed very irregular germination in some cases, and the effect of this was clearly observable in the results from the first few pickings. Later, when the roots reached the underlying sandy stratum, the growth became very rank, and the influence of irregular spacing was entirely masked. On the whole it would seem that Pump Scheme Strain and Webber 38 were rather favoured by this irregularity, and this possibly accounts for the relatively higher position of Webber 38 in the matter of yield in this plot.

SHENDI (PLOT II.) showed even more irregular germination, as the result of which large bare spaces were left in some of the beds. The "scatter" arrangement of the beds, however, was rather successful in equalizing out the effect, and it is probable that no particular variety was specially penalized. If anything, it would seem that Pump Scheme Strain and Webber 38 had been slightly favoured. This equalizing effect of bed-scatter was particularly useful in this case, as the effect of the blank spaces was very clearly observable in the yields of individual beds throughout all pickings, and would have been disastrous if it had been limited to one or two varieties only.

With the above considerations in mind, it is now possible to return to the tabulated results shown for the irrigated plots, and to

draw more definite conclusions as to the relative position of the varieties.

The final order of merit (*for yield only*) for these varieties in the northern Sudan during the present season would appear to be as follows:

1. Pump Scheme Strain.
2. Pedigree Dixie.
3. { Webber 38.
Massey's Selected Gendettu.
4. Delta Webber No. 1.

This order is based upon (1) the averaged results of all three plots, and (2) the detailed information available *re* germination, stand, etc., which is summarized above.

This ability to make a definite pronouncement on the relative performance of these varieties, in spite of plot irregularities and in the face of comparatively high standard errors, is very pleasing, especially in view of the very considerable time and labour involved in the compilation of the detailed records and in the process of reducing the data to usable form. It is very much to be hoped that the staff may be suitably strengthened in the coming season, in order to enable this line of research to be pursued and further extended.

The relative *value* of these types to the grower remains to be determined from a joint consideration of yield and spinning quality.

Samples of all these types are being submitted to the British Cotton Industry Research Association, but their reports on spinning quality, etc., will not be available for some months. For the present it is sufficient to note that the Pump Scheme Strain, Webber 38, and Massey's Selected Gendettu fall within the class of average Long Staple American, whilst Delta Webber is particularly long and fine, and may be expected to command a very useful premium. Pedigree Dixie, on the other hand, whilst still within the long-staple class, is decidedly shorter and rougher in character than the other cottons in the series.

The TALODI PLOT results have not so far been touched upon in this discussion, and are very interesting in that they differ very markedly from those obtained from the irrigated plots (see table of yields above). The plot itself showed a reasonable degree of regularity as regards stand of plants, except for certain differences in the number of plants per row, and for one or two patches where plants had visibly suffered from waterlogging or had even been washed bodily out of the ground.

The plot records here are very scanty, due to the inaccessibility of the plots, but the information available suggests that Delta Webber has been to some extent penalized by waterlogging, and that the first picking of Pedigree Dixie was materially reduced by the washing out of seedlings. The final order would therefore appear to remain unchanged.

The appearance of Delta Webber No. 1 nearly at the top of the list in this case is doubtless connected with the curtailment of the picking season by drought, which normally occurs in these parts as a result of the cessation of the rains. This variety characteristically produces a heavy early crop, but, under irrigated conditions, is not capable of the same sustained effort which is shown by the other varieties. This earliness is in turn connected with a tendency in this type to produce its first fruiting branch on the average one node sooner than the other varieties.

The relatively poor behaviour of the Pump Scheme Strain was apparently due to a higher degree of shedding under the particular conditions of growth at this place.

The good performance of Delta Webber No. 1 is especially noteworthy in view of the high quality of lint referred to above. Another feature which may perhaps make this variety specially suitable as a rain-crop is the tendency shown by open bolls to hang downward, thus minimizing the risk of damage by rain to the cotton whilst still on the tree.

The following notes on the special characteristics of varieties are based on observations in irrigated areas only.

Pedigree Dixie.—Production of fruiting branches begins low down on stem. Shedding is not very high compared with other varieties. More resistant to Blackarm than other varieties in the series. Lodges very badly.

Delta Webber No. 1.—Fruiting branches produced particularly low down. Rather susceptible to Blackarm. Sometimes inclined to lodge, but the short growth of the stems prevents serious entanglement.

Massey's Selected Gendettu.—Starts rather late in matter of fruiting branch production. More susceptible to Blackarm than others in this series. Not very inclined to lodge.

Pump Scheme Strain.—Similar to the last in matter of fruiting branches and lodging. Slightly less susceptible to Blackarm, but probably second worst in this respect.

Webber 38.—Apparently tends to be rather late in production of lowest fruiting branch. It shows average resistance to Blackarm. Upright habit, with stiff stem and very little tendency to lodge.

PRELIMINARY VARIETY TEST.

In addition to the above two "standard" series of variety tests, one other strip test was carried out on similar lines on the Experimental Farm at Shambat. The types tested were mostly new kinds, of which only a little seed was available, and the test was made to enable a preliminary weeding-out of undesirable sorts to be carried out.

The developmental records on this plot were particularly full owing to the ease with which it could be reached from the laboratory, but as the final yield results are of little general interest at this stage, only a very brief summary will be given.

The stand throughout the plot was very satisfactory, but soil irregularities were troublesome, and an attempt has been made to allow for these. The actual final yield results are summarized in the following table, the varieties being arranged in descending order.

PRELIMINARY VARIETY TEST. SHAMBAT EXPERIMENTAL FARM.

Average Yield per Feddan = 1.2 Large Kantars.

<i>Varieties.</i>	<i>Mean Bed Yield.</i>	<i>Standard Error of Mean Difference.</i>
S.I.D. 18	83.8 rottles	} 7.65
N.T. 25/24	71.4 "	
S.I.D. 14.1	66.2 "	
S.I.D. 3.2	65.4 "	
Massey's Selected Domains	59.4 "	
Garofallou	59.0 "	
S.I.A. 2.7.. .. .	47.2 "	
S.I.A. 7.1	40.4 "	

Corrections for soil irregularity suggested by our records would apparently leave the order unchanged, but would improve somewhat the figures shown for N.T. 25/24 and S.I.A. 2.7.

The variety known as "Massey's Selected Domains" is the type which is grown in bulk on the Experimental Farm, and was introduced into the series as a basis for comparison.

The relatively high yields of some of the varieties are doubtless due to some extent to their hybrid nature.

N.T. 25/24 is an Upper Egyptian type and extremely early compared to the rest, its earliness being definitely connected with a very rapid rate of node development in the early stages accompanied

by the power of producing fruiting branches at a very low node of the stem.

In S.I.D. 18 the fruiting branches also start comparatively low down, and shedding is not more than medium.

S.I.D. 14-1 is very similar to S.I.D. 18 as regards the above characteristics.

S.I.D. 3-2 tends to produce its first fruiting branches rather later, but shedding is on the low side.

As regards degree of Blackarm infection the standard type (Massey's Selected Domains) appeared to be the worst, followed by S.I.A. 7-1. The infection was in all cases slight in the present season. The extra degree of infection shown by the Massey's Selected Domains may perhaps be connected in part with the additional chances of seed infection which must have occurred in this case, as the variety has now been grown at Shambat for a number of years.

S.I.D. 18 showed markedly superior vigour to the other varieties in the plot.

(3) PEDIGREE LINE AND NEW SELECTION PLOTS.

An outline of the methods employed has already been given in last year's report, and the significance of the terms "New Selection" and "Pedigree Line" explained.*

In the present season the following types were dealt with:

Egyptian "Uppers"	..	..	..	21 New Selection families.
Sakel (Egyptian)	..	..	..	10 Pedigree Line families.
Affi (Egyptian)	..	..	..	1 Pedigree Line family.
Sea Island	..	..	..	{ 35 New Selection families.
				{ 89 Pedigree Line families.
American	..	..	..	{ 31 N.S. families.
				{ 44 P.L. families.

In order to avoid as far as possible the danger of outcrossing between the American cottons and the Egyptian types which constitute the main crop of the farm, the American families were segregated in a small area well away from the rest. Sowing was carried out between July 8-11, and the stand was on the whole satisfactory, though considerable losses were sustained at a later stage from the attacks of the larva of the Stem Borer beetle.

The methods employed in making observations in the field were similar to those of last year. It has been found possible, however,

* See Reports received from Experiment Stations 1925/26, pp. 125 and 130.

to extend the laboratory records so as to give more complete information. The following points were dealt with in the laboratory:

Yield of seed-cotton.
Yield of seed (natural and self-bred).
Halo length.
Regularity of length of hairs (vertical and tangential).
Fineness, "toughness" and lustre of fibres.
Fuzz characters of seeds.
Ginning out-turn (percentage).
Weight of 100 seeds.
Lint index.
Hair-weight per centimetre.

The following very brief notes are given with reference to the families shown above in the same order as that in which they occur in the list.

EGYPTIAN "UPPERS" (N.S.).—All these families were extremely early compared with any other families in the Egyptian and Sea Island Plot, and this extra earliness was definitely associated with a "fruiting zone" situated low down on the plant axis. The first fruiting branches were usually produced from the eighth or ninth axils of the stems. For the most part, these families were low-growing, and were more affected by drought than the other types. This tendency to "thirstiness" was later found to be connected with a root system well developed in the upper layers, but with little power of vertical penetration.

The families grown represented two different types of Upper Egyptian—viz., a selected Ashmuni and a new type known as "N.T. 19/24." The latter type proved to be very similar in behaviour here to the Ashmuni, but was a trifle later, and the average lint length (halo) came out at about 29 mm. instead of about 27 mm. Yields on the whole tended to be rather bigger than those obtained from Sakel P.L.'s. Final selections were made as follows for sowing next year:

Ashmuni		{ 5 plants for P.L. (Pedigree Lines).
		{ 3 plants for N.S. (New Selections).
N.T. 19/24		{ 8 plants for P.L.
		{ 1 plant for N.S.

SAKEL (P.L.'s).—All these families were late and "leggy," and the lowest fruiting branches rarely appeared before the twelfth to fourteenth axil. One family derived from "Sakel 176" gave a satisfactory yield, and was reasonably pure. The halo-length in this case was round about 35 mm., and the ginning outturn and lint index, as well as quality of lint, were satisfactory.

Final selections were made as follows:

From " Sakel 176 " derivative		4 plants for P.L.
From other Sakel families		5 plants for N.S.

AFIFI (P.L.).—Only one family had been grown from this stock, but the results obtained in the matter of earliness and yield were sufficiently encouraging to warrant further selections being made. The halo lengths came out about 28 to 35 mm., the family being apparently not pure in this respect, as also in the matter of flower colour and degree of monopodial development.

Selections made		{ 3 plants for P.L. 1 plant for N.S.
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SEA ISLAND (N.S.).—These families were grown from single plants picked out of the small plots of Sea Island at Shambat in the previous year (Types A, B, C, and D). They mostly showed hybrid origin, and were unsatisfactory in other respects.

Only five plants were selected (for N.S.'s.).

SEA ISLAND (P.L.).—Out of the total of eighty-nine families, ten were grown from plants selected from families growing at Shambat in the previous season. Of these only two families proved to be worth considering. These were derived originally from single plants introduced from Egypt, where they had undergone previous acclimatization. Both had failed to produce any bottom-crop, and in consequence were tall and leggy, but the top-crop was decidedly heavy, and the quality of the lint fair, but lacking in strength. Compared with the Sakels, their performance here was satisfactory.

The remaining seventy-nine families in this plot were grown from seed supplied by Mr. L. H. Burd from his breeding plots at St. Vincent. Mr. Burd at the same time very kindly supplied details as to the origin and nature of the varieties sent, and the results have proved decidedly interesting. The seed sent included several different original types, often widely distinct in vegetative habit, but in general the growth of the plants compared very favourably as regards general vigour and yield with the Sakel families grown in the same plot. The quality of the lint, as was expected, was not up to Sea Island standards, but this is not considered to be a drawback, provided that it falls within the range of Sakel cotton, which it might conceivably replace.

The most satisfactory type-groups were those which derived their origin from Burd's "AN" (our families 22/26-41/26), "AE" (our families 42/26-51/26), "BD" (our families 55/26-57/26), and GX. 12 (our families 61/26-90/26). All families bred very true, considering the upsetting influence of their transference to Sudan conditions.

Some groups were unsuitable in habit of growth to our conditions, as for instance the "A.J." group, which was definitely procumbent in its growth. Practically all the families were superior to Sakel in the comparatively low position of the first fruiting branches. These branches, however, usually showed very heavy shedding. Despite this the zone where bolls are formed *and retained* was characteristically lower than in the Sakels, and the later top-crop was also usually heavier. On the whole, the plants were more vigorous, less leggy, and much less inclined to lodge than the Sakel families. Good stands were usually obtained, and the effect of scorching winds was rather less marked than in Sakel. The above remarks apply to all groups in general. The following additional notes bring out some of the special features shown by individual groups:

Group A.N.—Monopodial growth is strong compared with Sakel, but usually contributes to the crop. Halo length variable, mostly about 37 mm. Late. Yields quite good. Quality barely up to good Sakel in most cases.

Group A.E.—Some plants managed to set quite a lot of bolls on their lower branches. Halos varied from 37 to 41 mm. Axillary bolls were frequently produced, and shedding was rather less than in most families here. Yields were fair.

Group B.D.—Distinct from most other families in showing very slight development of monopodial branches, and in retaining their first foliage leaves for a longer period than most. Like other groups the plants were late. Halos similar to A.E. Group. Yields fair. Quality rather good.

Group G.X. 12.—Contained several subtypes. One type was markedly tall with long fruiting branches, and gave good yields of cotton of quite good quality. The ginning out-turn and lint index were also satisfactory. Another type was noted as especially vigorous, with rather less shedding than in most cases, and was found to have lint of satisfactory quality (halo 37 to 41 mm.).

Final selections were made from the above groups as follows:

Sea Island from Egypt	..	..	..	{ 3 plants for P.L.
				{ 1 plant for N.S.
Sea Island.	Burd's "A.N."	..	..	{ 21 plants for P.L.
				{ 1 plant for N.S.
" "	" "A.E."	..	..	6 plants for P.L.
" "	" "B.D."	..	..	7 " " P.L.
" "	" "G.X. 12"	..	..	19 " " P.L.

In all the Groups referred to above, a tendency was noted for the bolls to open badly. This same tendency had been observed in

other Sea Island families in the previous year and would appear to be characteristic, but from experience with this variety in Egypt it seems probable that some improvement can be effected by selection. Some of this faulty opening may be attributed to defective pollination, and there is reason to think that the receptive surface of the stigmas was actually damaged by heat in the case of flowers which opened during the hot weather in September. Bolls formed during that period were frequently asymmetrical and "tip-tilted," due to the partial or complete failure of the ovules to develop in one or more loculi.

Another factor of great importance is obviously the extent of damage by bollworms, but here a detailed examination of two families, one Sea Island and the other Sakel, appeared to show that the Sea Island was, if anything, rather less affected by these pests than the Sakel.

A noticeable feature in connection with the bolls of Sea Island cotton was the development of a dark red pigment on the outside of affected bolls. This red pigment was almost always observable in cases of bollworm damage, but frequently occurred when bollworms were not present. Its development was certainly connected with the incidence of light, as it rarely developed in situations where the surface of the boll had been protected from the light by overlapping bracteoles. It seems probable that it may be a direct "sunburn" effect, to which the tissues are rendered more liable when damaged by bollworms or other insects. There is a general tendency for these reddened patches to become prematurely dry and hard, with the result that the affected valves are unable to open properly. This reddening, whatever its cause, is much more prevalent in the case of Sea Island bolls than in Sakel bolls, and in the particular case examined it was found that the percentage of *pickable* bolls was about 10 per cent. less in the case of the Sea Island family. This question will receive further study in the coming season. A comparison of the behaviour as regards length and fineness of lint of the Sea Island strains, when brought from St. Vincent to the Sudan, has given interesting results. The table on p. 167 shows the results of detailed examinations made on eighteen different plants belonging to seven different families, compared with the figures supplied by Mr. Burd for the group values of these characters.

An inspection of this table shows at once the remarkable reduction in length of the fibres, even allowing for differences in the method used for determination. The hair-weight per centimetre figures (taken here as a measure of fineness), as determined at Shambat,

ST. VINCENT.			SHAMBAT.		
Reference Number of Strain.	Halo Length (Mm.)	Hair Weight per Cm. (Mgm.)	Reference Number of Family and Plant.	Halo Length (Mm.)	Hair Weight per Cm. (Mgm.)
A.N. 25, 25, A. 10 ..	50.3	·00119	23/26 18	37.4	·00156
			„ 20	37.6	·00163
			„ 22	37.3	·00151
A.N. 25, 26, E. 9 ..	50.3	·00119	41/26 17	39.5	·00173
			„ 18	40.1	·00117
			„ 23	39.0	·00144
A.E. 25, 27 (26) ..	52.0	·00116	43/26 3	40.4	·00118
			„ 4	40.1	·00138
			„ 5	39.6	·00101
G.X. 12. 25, 32, A. 14. .	50.9	·00101	61/26 9	38.5	·00163
			„ 13	40.0	·00104
			„ 22	37.5	·00126
G.X. 12. 25, 34, E. 4 ..	50.9	·00101	75/26 17	39.8	·00112
G.X. 12. 25, 35, A. 11	50.9	·00101	76/26 2	38.1	·00125
			„ 5	40.1	·00104
			„ 8	39.4	·00119
G.X. 12 V. 25, 36, E. 5	52.0	·00108	95/26 5	41.8	·00112
			„ 13	39.4	·00122

show a wide range of variability from plant to plant. In one case (Plant No. 43/26.5) the lint would actually appear finer than it had been in St. Vincent. In the majority of cases, however, it is considerably coarser, frequently approaching Sakel standards in this respect (*e.g.*, Plants 43/26.4 and 23/26.22). In a few instances it shows itself even coarser, and in the case of 41/26.17 reaches the figure which may be taken normally to represent Upper Egyptian.

The method of sampling employed by us was somewhat different from that employed at the Shirley Institute, Didsbury, but otherwise the technique was similar. Figures from the Shirley Institute appear to give the following values as representing the different types when normally grown:

Sea Island	=	·00112	mgm. per cm.
Sakel	=	·00136	„ „ „
Uppers, Egyptian	=	·00187	„ „ „

In carrying out the work at Shambat we encountered an apparent difference in hair-weight per centimetre between long and short hairs from the same seed, as shown by the following example in which successive “pulls” were taken from the same portion of the seed:

<i>Plant No. H. 9/26 (N.) 50.</i>				<i>Hair Weight per Cm. in Mgm.</i>
Long fraction (first pull)	..	..	..	·00174
Med. long fraction (second pull)	..	..	..	·00145
Med. short fraction (third ")	..	..	..	·00129
Short fraction (fourth ")	..	..	..	·00116
Full sample	..	..	..	·00146

This apparent correlation between shortness of hair length and lowness of hair-weight does not agree with the work that has been carried out at the Shirley Institute, and is being further investigated with the friendly assistance of Professor W. E. Morton and the staff of that Institute.

AMERICAN (N.S.).—The families grown in this plot all originated from the seed of single plants selected from last year's " Observation Plots " at Halfya Meluk. In all cases the parent plants showed some difference from the average plants in those plots, a difference either of kind or degree. The varieties represented were: Delta Webber, Lone Star, Lightning Express, Meade, Columbia. The N.S. families showed no very special improvement on the type, but satisfactory yields were obtained from one family of Lone Star origin. Final selections were made as follows:

From Delta Webber	..	..	5 plants for P.L.
" Lone Star	..	..	3 plants for P.L.
" Lightning Express	..	..	2 plants for P.L. and 1 for N.S.
" Columbia	..	..	8 " " P.L.
" Meade	..	..	3 " " N.S.

AMERICAN (P.L.).—The parents of these families were also selected from the Observation Plots at Halfya Meluk, and should, strictly speaking, have been tried out in the first instance in " N.S." plots. In view, however, of the fact that they were specially selected as representing the type, as shown by the great majority of plants in these plots, it was considered more convenient to treat them from the start as Pedigree Lines. The origin of the strains from which they were taken was made clear in last year's report, and will not be referred to again here.

The following few notes on this year's families are worth recording for future reference:

Meade.—All families were very late, and in very few cases did they show signs of breeding true. Yield usually low, but fair yield was obtained from A. 3/26 (S). Halo lengths ranged from 27 to 37 mm.

Cleveland.—Nothing special. Short lint (23 mm.).

Columbia.—Nothing special.

Delta Webber.—Most of the families bred true or nearly so. All

were distinctly early and gave fair yields of good quality. Halos long (29 to 31 mm.).

Pedigree Webber.—Rather strong growers. Halos about 26 mm. Ginning out-turn rather high.

Pedigree Dixie.—Vigorous and good yielders, but lint short and variable (24 to 29 mm.), and often rough.

Gendettu.—Late starter, but final yields good. Halo about 30 mm. Decidedly prone to shedding.

Lone Star.—Early and fruitful. Halo 26 to 29 mm.

Durango.—Rather vigorous and fair yield. Shows high tendency to shed. Halo 27 to 31 mm.

Hanik.—Very tall. Late, but good final yield. Lint 29 to 32 mm.

Final selections were made as follows:

Meade	..	..	..	..	5 plants for P.L and 3 for N.S.
Cleveland	..	..	..	1	” ” P.L.
Delta Webber	..	..	..	11	” ” P.L. and 3 for N.S.
Pedigree Webber	..	..	..	3	” ” P.L.
Pedigree Dixie	..	..	..	2	” ” P.L. and 2 for N.S.
Gendettu	..	..	..	3	” ” P.L.
Acala	..	..	..	2	” ” P.L.
Lone Star	..	..	..	3	” ” P.L.
Durango	..	..	..	2	” ” P.L.
Hanik	..	..	..	2	” ” P.L.

(4) HYBRID PLOT.

In this plot twenty-nine families were grown, and field and laboratory observations made similar to those carried out in the case of the “P.L.” plot.

The first eleven families originated from material handed over to me by Mr. Massey. One of these families, H. 10/26, though by no means breeding true, gave good average yields and halos of useful length (34-39 mm.). The lint was whitish in colour and rather harsh. Lint index and ginning out-turn satisfactory. Three plants were selected from this family, whose origin is supposed to be a natural vicinist between Sakel and Sea Island.

All the remaining families represented the fourth generation (F. 4) from a cross made in Egypt between Sakel and Sea Island, the preceding generations having been inbred. Most of these families were still far from breeding true, but some had become almost stabilized as far as vegetative characters at any rate were concerned. These families showed many interesting features, but cannot be dealt with in full detail here. One (H. 22/26) bred true for susceptibility to Thrips attack. Many of the families contained plants with dark brown lint, sometimes associated with length and high quality of

staple. White and Sakel-coloured cottons of good quality have also been noted, and there is little doubt that some of these at any rate can be "fixed." It has been encouraging to note a general tendency to vigour amongst these families as compared with the neighbouring Sakel plants, and detailed records suggest that this vigour is not entirely due to heterosis. Another feature of importance noted was that the ginning out-turn was frequently on the high side—a feature not observed in pure Sea Island. On the whole, the material looks decidedly promising, but in the majority of cases the plants are far from satisfactory in the matter of shedding and boll-opening. The general impression was gained that better results would have been obtained with later sowing. Altogether thirty-five plants were selected from this F. 4 generation for growing-on next year.

New Crosses.—A certain number of new crosses were made during the present year, Sea Island and Upper Egyptian types being used as parents. Both parents in this case may be expected to carry the factors involved in the early production of fruiting branches and in a strongly developed surface-rooting system. Amongst the segregates from this cross it should be possible to find plants which possess the resistance to early shedding shown by the "Uppers" parent, and the length and quality of lint combined with the power of deep root-penetration possessed by the Sea Island type.

(5) NEW ORIGINAL SELECTIONS.

These have been made both from field crops and propagation plots, and also from amongst the separate families in the breeding plots. In all cases they represent some apparent improvement on the type from which they were selected.

In view of the satisfactory performance as regards yield of the locally established type of American cotton (known as "Pump Cotton") some considerable time has been spent in selecting good individual types from the mixture of which that crop is composed. Some of these latter selections were made from crops in the "rain grown" area, with the particular object of obtaining types useful for those conditions. The following is a list of the new selections made:

<i>American</i> "Pump Scheme"	..	..	..	..	..	17
"Meade"	..	..	..	..	..	7
"Pedigree Dixie"	..	..	..	..	..	6
Various	..	..	..	..	..	7
<i>Upper Egyptian</i>	..	..	..	..	..	13
<i>Assili</i> (Nahdah and Afifi)	..	..	..	..	..	3
<i>Sakel</i>	..	..	..	..	..	18
<i>Sea Island</i> : From families grown from Burd's seed	..	..	..	..	..	12
Other kinds	..	..	..	..	..	23

(6) PROPAGATION.

(a) *Small Scale*.—Plots of different varieties were grown at the farm at Shambat, with the object of maintaining nucleus supplies of certain kinds which were either actually in process of trial in variety tests, or considered likely to prove useful in the near future. These plots varied from $\frac{1}{100}$ to $\frac{1}{3}$ feddan in extent, but in all cases a small area was “taped off” in the centre, within which systematic “selfing” of flowers was carried out throughout the season.

The varieties dealt with in this fashion included the following:

<i>American.</i>	<i>Egyptian.</i>	<i>Sea Island.</i>
Columbia 44	Nahdah	S.I.D. 1, 8.
Delta Webber No. 1	N.T. 25/24	S.I.D. 3, 2.
Pedigree Dixie	Sakel 186/24	
Massey's Gendettu	Bolland Sakel, 8	
Meade E.C.G.C.	” ” 19.3	
„ B.P.I.	Garofallou	

The origin of these strains has been explained in last year's report.

(b) *Large Scale*.—The whole of the cotton area of the Shambat Pump Station, adjoining the Experimental Farm, was sown with the strain of Sakel which was referred to in last year's report as “Massey's Selected Domains,” the total amounting to 490 feddans.

A field of 20 feddans in the centre of this area was reserved as a special “roguing area,” and was sown, rogued, and picked under the direct supervision of the Plant Breeding Section. The seed from this plot will be used in the coming season for sowing the Main Shambat area, which will in this way come to bear increasingly pure crops of this strain. In addition, seed can be supplied from this source direct to the nucleus plot at Barakat.

As stated in last year's report, this strain of cotton was very favourably reported on by buyers in England, and fetched premiums over the price paid for Sakel of the same grade, which in one case amounted to 200 points.

(7) SPINNING TESTS.

The results of a first series of spinning tests, carried out by arrangements made through the office of the Empire Cotton Growing Corporation, are now to hand, together with a report on the measurable characters of the same cottons supplied by the British Cotton Industry Research Association. The samples submitted were from the previous season's crop, and the grading and spinning tests support on the whole the decisions made as to the varieties which should be included in this season's American variety tests.

The examination of measurable characters reveals an unusually high proportion of immature or thin-walled hairs in all the samples, a fact which has led to abnormally low hair-weight-per-centimetre figures for this class of cotton. These samples had been, of necessity, ginned out on a small hand gin, and were in many respects unsatisfactory. All ginning of samples will, in future, be carried out on the newly installed full-sized roller gin at Shambat.

Arrangements are in train for spinning tests to be carried out on a wide and representative series of samples from the current year's crop, from which it is hoped, *inter alia*, to obtain valuable information as to the effect of the date of picking on the quality of the cotton picked, a question which is of the very highest importance in the Sudan, where the picking season at present extends right through from the comparatively cool winter to the excessively hot and dry months of April and May.

We are deeply indebted to the British Cotton Industry Research Association, as well as to those individual Spinners and Brokers who have so kindly devoted a considerable amount of time and labour to our problems, and without whose co-operation it would be impossible for us to obtain that information as to the actual behaviour of the cotton in the mill, which is the final criterion of success or failure.

(8) DEVELOPMENTAL OBSERVATIONS ON COTTON PLANTS.

(A) *Plants Grown in Boxes*.—The work alluded to in last year's report has been continued, and a complete monthly series of Egyptian (Sakel) and American plants has been sown and grown throughout the year in large wooden boxes. A record, as complete as time permitted, has been kept of all developmental characteristics exhibited by the plants, together with observations on soil temperature. The records made included such points as rate of germination, rate of laying down of nodes, position of origin of the first fruiting-branch, rate of development of buds along the branches, degree of shedding of branches, buds, and bolls, extent and location and orientation of growth of monopodial branches, and notes on the direct observable effects of specially rigorous environmental conditions, such as sandstorms or periods of exceptionally high or low temperature. The experiments are still in progress, and it is hoped to embody the final results in a paper specially devoted to this subject. The following are some of the points of interest noted:

(a) Rate of germination, as measured by the interval between sowing and the appearance of the cotyledons above the soil, varied very much according to the season, the longest interval (eight days) being recorded in mid-January, and the shortest (three days) during the months of May, June, and July.

(b) The time taken for individual flower buds in the case of Sakel cotton to develop from their primordia varied by several days at different periods of the year, thus disagreeing with observations made in Egypt. It should be noted, however, that the Egyptian observations referred only to the summer season in that country.

At Shambat the total maturation period of buds developing during the period December to early February was in the neighbourhood of fifty-one days (very approximately), whereas that for buds developing in the hot period between mid-March and early May was, very roughly, about forty-six days. Both these periods are notably longer than the period estimated for Sakel in Egypt, which was forty-two days only, the conditions of growth being similar as regards the size of the boxes. Much variation was also found to occur at Shambat in the length of the period during which the sympodium internodes continued to elongate. Our data on this point are not sufficiently numerous, but as they stand they do not give any clear indication of seasonal differences in this respect.

(c) The extent and kind of development of monopodial branches has been found to depend to a surprising extent on climatic influence. This may be roughly summed up in the case of Sakel plants as follows:

August to October sowings produce, near the base of the plant, a few large monopodial branches which are carried almost horizontally.

January sowings produce large basal monopodia (slightly more in number than the foregoing), which grow out horizontally for about one-third of their length, and then, when the weather becomes really hot, turn upwards and continue their growth almost vertically.

March to May sowings produce twice or three times the number of branches, which tend to start a little higher up above the level of the cotyledonary node, and are carried much further up the stem. These branches are not so stout as those which started in the winter months, and are strikingly vertical in direction of growth from the very start.

(d) The most striking seasonal effect of all is the behaviour of the fruiting branches, the growth of which appears to be actually inhibited during the hotter periods, especially in the case of Sakel cotton.

Sakel sown in October behaves in this respect very much as it does when grown during the normal cotton season in Egypt; in other

words, it produces good-sized effective fruiting branches from the eighth axil of the stem upwards. As the bolls on these come to maturity the plant enters a resting stage, and then enters a second period of fruiting branch production of similar but rather less vigour than the first. Both these periods of bud-formation fall within the cold or reasonably cool season of the year.

With plants sown in mid-March the case is somewhat different. Fruiting branches tend to start fairly low down as their early development takes place before the hot weather has properly set in. After that the plant carries on producing branches of irregular length, usually short, and often failing altogether.

The extreme case is shown in May-sown plants, which are met with the hottest of weather from the very beginning. Here we find that fruiting branches are not produced at all, but the plant goes on growing until the short rainy season produces more favourable conditions. A start is then made—perhaps as late as the twenty-fifth node on the main stem—and a few fairly well formed branches produced at the top of a tall leggy plant, but with the renewed onset of the hot weather after the rains cease this belated attempt is abandoned.

The importance of a recognition of this behaviour as regards time of planting is obvious.

(B) *Root Development*.—A series of observations was carried out in order to obtain an insight into the subterranean factors on which the aerial growth in great measure depends. In particular it was desired to discover, if possible, whether the different types of aerial habit shown by varieties, and their varying response to the climatic environment were in any way connected with differences in their root systems. The experiments were conducted by sowing Sakel, Upper Egyptian, Sea Island, and American types in the same plot, and digging out the root systems of a certain number of plants every month for five months. These special observations were supplemented by the digging out of other plants in various parts of the farm for comparison. The results have not yet been fully worked up, and the influence of small local irregularities in soil conditions has confused the issue to some considerable extent, but, given the normal Shambat soil conditions with a layer of very heavy soil lying at about half a metre below the surface, it would appear that the plant-roots reach this layer by the end of the first month's growth. The second month appears to be spent in more or less unsuccessful attempts to penetrate this layer, with considerable abortion of root tips. At the same time a great extension in lateral growth above the "pan" layer takes place. In the third month great extension

in length of the laterals tends to take place and attempts at depth penetration continue, the result of which is either failure or some slight measure of success. In the latter case considerable development, both vertical and horizontal, takes place during the fourth month in the more sandy soil underlying the "pan." The surface system during this time branches and thickens up. The difficulty experienced in forcing a way through the pan is clearly seen in the roots themselves, which in this zone are thin, hard, and much contorted.

Certain varietal differences appeared in the relation of the plants to this hard layer of soil. Upper Egyptian plants had a particularly poor power of penetration, but were characterized by very long, stout, branching laterals in the upper layers (doubtless connected with the tendency of this variety to go "thirsty" sooner than others). Sea Island has an almost equally well developed surface system, but combines with it a considerable power of depth penetration. Sakel appears to occupy an intermediate position in both respects, and the root system as a whole appears rather to lack vigour. The American plants examined (Delta Webber) had roots of altogether distinct "texture" and colour. Laterals were as a whole poorly developed, and the plants seemed to have suffered considerably in those cases where they failed to penetrate the pan. It would seem possible that growth in depth is essential to this kind, and it may be the reason for the poor performance put up by American cotton on the Shambat Farm. It is hoped that, as our knowledge of this subject increases, it may in time be possible to predict with some chance of success the behaviour of the plants under a variety of conditions, and to make recommendations that certain varieties should be grown in certain situations and areas.

(9) EARLY TOPPING EXPERIMENT.

This experiment was undertaken as a side-line, and arose out of the developmental observations on fruiting branches which have been already described. Topping has often been carried out in cotton, but, as far as I am aware, it has always been done in the case of rather rank growth and at a time when the crop has already started to set on the lower branches.

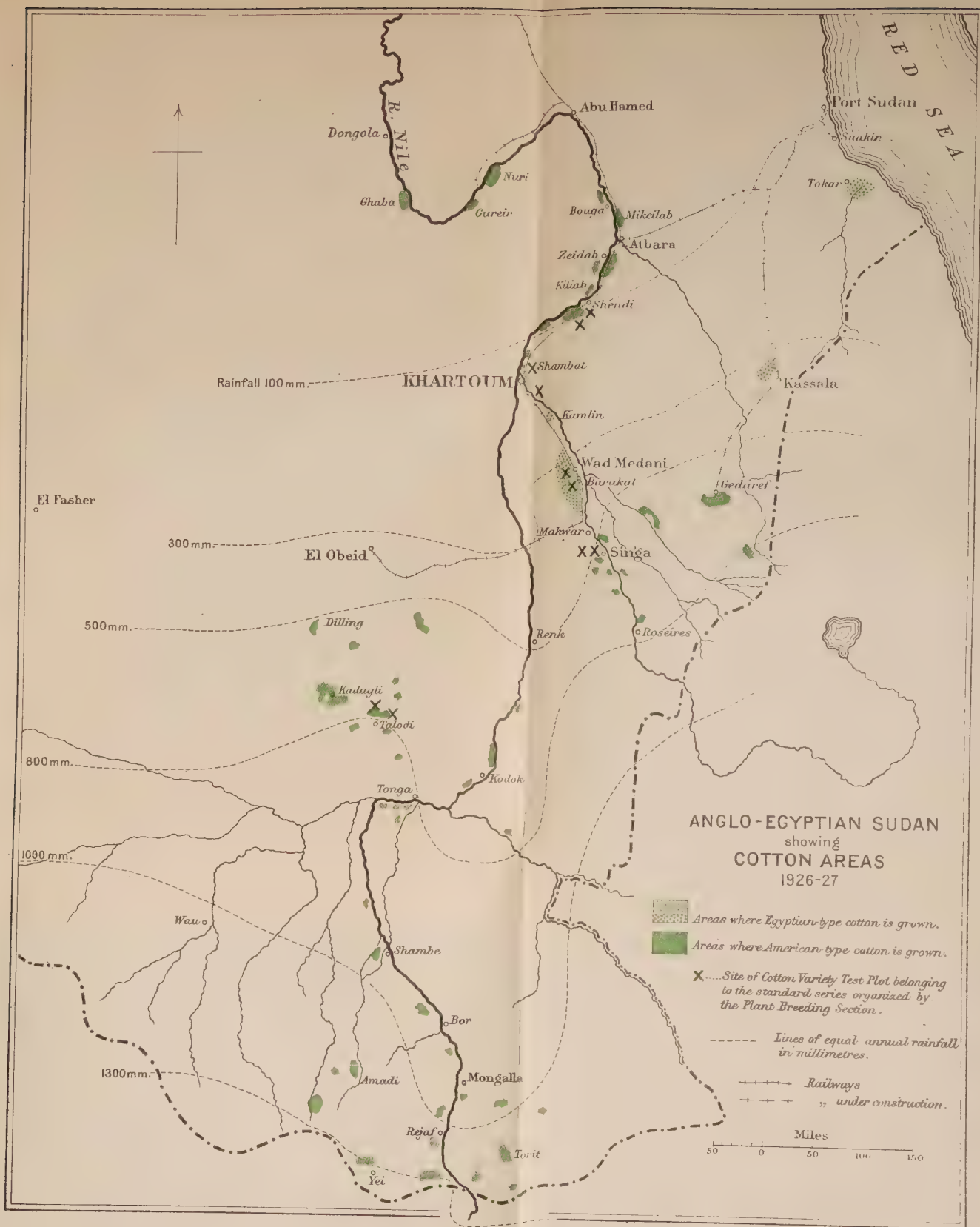
The considerations which led to the present experiment being carried out were as follows: Observations on "box plants" show that the conditions are especially favourable for bud formation in October and November. If, however, planting is delayed as late

as would seem necessary, another factor comes in—namely, actual cold with its attendant slowing-up of all the vegetative and reproductive processes (direct *damage* from low temperatures is probably of very rare occurrence). It would seem possible that the ideal might be achieved by planting in, say, August, and allowing the plants to get well established, and then cutting right back to the fourth or fifth node at a time which would allow the new branches which are produced to start their growth under the optimum conditions. In this way we should get well-formed root-systems, each bearing three or four strong shoots above ground, which should be able to settle down at once to the business of flower- and fruit-production under the most advantageous circumstances.

The experiment in this last season was carried out on Sakel sown on July 19. Two different times were chosen for topping—namely, four weeks and six weeks after sowing—all the plants being cut away above the third leaf-axil in each case. Four repetitions of each time of cutting were made, and ten beds left as controls. The experiment was not sufficiently conclusive, but showed, if anything, a slight additional yield (4 per cent.) from the beds topped one month after sowing. The yield from the late-topped beds was less than that of the control. A similar trial will be made in the coming season.

CONCLUSION.

The results obtained in the various investigations detailed above appear to justify a continuation of the work along the same lines. In particular, an effort will be made further to improve the system of taking serial records in connection with Variety Test Plots, as this has proved itself to be of real value in interpreting the results obtained.



(Included by courtesy of the Uganda Government.)

UGANDA

REPORT ON COTTON EXPERIMENTS, SERERE STATION, SEASON 1926-27

BY

G. W. NYE AND A. B. KILLICK.

THE programme of experimental work for 1926-27 was an elaboration of that of the previous season for Serere and for outlying districts.

The Government Plantation at Serere consists of about 400 acres, of which over 120 acres have been cleared and are in cultivation. The main part of the farm slopes in a north-easterly direction, and on this land there is considerable rain-wash after heavy falls of rain. The soil is a deep clayey loam, and is easy to work except after very heavy rain. There are a few outcrops of ironstone in some plots.

The average rainfall at Serere varies from 50 to 60 inches, with the dry season occurring in December and January. The success or failure of the cotton crop depends on the months in which the heaviest falls take place. Usually if heavy rains are experienced in October and November the crop is a comparative failure.

TABLE I.

MONTHLY RAINFALL AT SERERE SINCE THE OPENING OF THE STATION.

<i>Months.</i>	1920.	1921.	1922.	1923.	1924.	1925.	1926.	1927.	<i>Monthly Means.</i>
January ..	—	0.68	0.20	0.32	0.00	0.83	2.91	0.11	0.72
February ..	—	1.60	3.20	2.85	4.73	0.72	2.59	0.95	2.38
March ..	—	0.72	6.63	6.77	1.58	5.95	3.96	4.67	4.32
April ..	—	4.32	3.78	8.86	13.29	6.26	13.29	8.56	8.33
May ..	—	5.88	4.82	9.02	5.81	5.44	4.35	7.67	6.14
June ..	—	5.99	6.91	3.57	3.87	6.99	4.66	2.41	4.91
July ..	3.93	9.56	2.64	9.11	2.71	5.25	3.90	3.26	5.04
August ..	6.57	2.61	9.27	7.17	7.10	5.63	8.10	—	6.63
September ..	6.39	5.01	4.04	8.41	3.98	3.46	8.92	—	5.74
October ..	2.68	4.63	3.61	6.96	5.03	7.74	7.22	—	5.41
November ..	3.07	1.54	2.85	1.50	4.47	6.89	9.61	—	4.28
December ..	0.64	0.56	1.50	1.69	1.09	1.51	0.00	—	0.99
Totals ..	—	43.10	49.45	66.23	53.66	56.67	69.51	—	54.89

The season 1926-27 proved to be a very bad one for cotton, owing to heavy October and November rains and to the excessively dry months of December and January. The yields on the Plantation fell to an average of 350 lbs. of seed cotton, as compared with 750 lbs. for the previous year. The causes for the drop in yield are discussed under the heading of Selection Work.

Cotton experimental work in Uganda is divided into two sections—viz., Selection and Cross-breeding work, and Field Experiments, both of which are chiefly concerned with increase in yield. The selection work is the most important at present, quicker results being obtained from it than from the field experiments. The latter are recognized as being of great importance, and are an essential corollary of selection work, but owing to the necessity of repeating spacing trials in as many areas as possible on account of soil and climatic variations, and to the necessity for European supervision to ensure accuracy of results, it is impossible to extend the scope of these trials any further than has been done already. Cross-breeding is engaging attention, but to obtain results of value commercially takes too much time, and is too uncertain for the work to be carried on in great detail.

SELECTION WORK.

Fifty-two progeny rows were sown in mid-July on a new piece of the block reserved for experimental purposes near the laboratory. These included single plant selections from the following varieties, Nyasaland Upland, Allen, Meade, Salisbury, Webber Upland and Acala, and also two strains of Sea Island and one of Pima.

Until the middle of September the development of the plants as a whole was excellent, although Spiny Bollworm had done a certain amount of damage to main shoots and young buds, and Angular Leaf Spot had appeared on some plants. On September 22 a very severe and devastating hailstorm swept over the plantation, causing a great amount of mechanical damage, snapping off about 6 inches of the main stems and strewing the ground with leaves, buds and young bolls. Curiously enough, an inspection of the flowering curves only shows a comparatively small depression after the storm, after which the curves follow very closely those of last year, except that the rate of flowering is not so high. The bolling curve, however, does not exist, as only about 20 sound bolls were picked from the 1,200 odd plants on the plot.

This total failure cannot be entirely due to hail effect, as 75 per cent. of the flowers were formed after the storm, and the bolls from these must have been lost from other reasons.

The following list gives the responsible factors:

1. Mechanical damage by hail, causing loss by shedding of young bolls and buds and by the breaking off of shoots potentially boll-bearing.
2. Entrance of diseases through wounds caused by hail.
3. Excessive rainfall in October and November, causing shedding of buds and young bolls and enabling boll-rots to become serious.
4. Very dry period of December and January, causing shedding and premature opening of bolls, the latter being very bad.
5. Jassids, which were given their opportunity by the dry weather, and which were probably the most serious agents in destroying the crop.
6. Bollworms and stainers, which were not more serious than former years.

All plants from the progeny rows were uprooted by the end of January, as they were merely dried-up sticks, whereas in 1926 all plants were flowering profusely after the end of March.

F2 rows were also a failure, not a single boll being picked from them.

The effect of this season in causing total loss has shown up the danger of entirely losing valuable strains where seed is limited and where two such seasons occur consecutively. With this danger in view it is hoped that in future seasons it will be possible for progeny rows of some of the strains to be grown at some other station, as well as at Serere, where they can be selfed and harvested properly so as to form a sort of insurance against total loss.

INCREASE PLOTS.

Four strains, SG 15, SG 26, SG 27, and SG 29, selected from last year's progeny rows, were sown in small bulk increase plots, varying in size from $\frac{1}{4}$ acre upwards according to the seed available. Each plot was completely segregated from any other cotton, and as an extra safeguard was surrounded by a thick belt of Kapenda (*Cajanus indicus*).

Careful roguing was done throughout the season, and a boll analysis was made on one hundred bolls from each plot, giving results summarized in Table II. on p. 180.

Comparing these results with those of last year, it is seen that the strains have kept remarkably true to type. The longer staple and

higher weight of lint per boll for all strains in 1926-27 were probably due to climatic conditions.

As only the one plot of each was grown, no comparisons can be made for total yield, but examination of Table II indicates that SG 29 is physiologically a higher yielder than the others, and this should be the case provided that it is not a high shedder.

Lint samples of these cottons were sent home for spinning tests, the results of which are recorded in the appendix.

TABLE II.

<i>Strain.</i>	<i>Loculus Number.</i>	<i>Seeds per Boll.</i>	<i>Weight Seeds per Boll.</i>	<i>Weight Lint per Boll.</i>	<i>Lint Length.</i>	<i>Lint Index.</i>	<i>Ginning Outturn.</i>
SG 15 ..	4.09	31.89	3.72	1.63	31.9	5.11	30.41
1925-26 ..	4.15	31.07	3.69	1.47	31.9	4.87	28.2
SG 29 ..	4.09	33.28	3.85	1.87	29.96	5.63	32.7
1925-26 ..		31.8	3.86	1.76	30.2	5.64	31.3
SG 26 ..	4.08	33.65	3.54	1.79	29.0	5.31	33.5
1925-26 ..		31.1	3.57	1.49	29.2	4.80	29.4
SG 27 ..	4.10	33.12	3.75	1.73	29.9	5.23	31.6
1925-26 ..		30.9	3.74	1.58	29.7	5.12	28.8

FIELD EXPERIMENTS.

It was realized after last season that the main sowing date and spacing experiments should be combined in order to obtain the fullest information, as it appeared probable that wider spacings would be best for early-sown cotton owing to the greater vegetative development, while close spacing for late-sown cotton would help to balance the loss of a great part of the potential bolling power through the approach of the wet season in March. Accordingly, for this season five spacings were sown at three sowing dates, making a total of 75 plots.

In dealing with sowing date experiments, it is important that proper allowance be made for the filling up of blanks, as these are usually sown a month after the original seed was sown, and so really belong to another sowing date. Gaps cannot be left, as the plants on either side have an advantage on account of greater spacing, and the germination varies according to the weather conditions at the

time of sowing. This being so, the figures for yield per plot cannot express a true index unless it be that the error for gaps even themselves out for each planting, and until this is proved the yields from sowing date plots should be given as yield per so many plants, these plants being selected as being those from the initial sowing.

This year observation rows of ten plants per plot were demarcated, and on these plants data for growth, flowering and bolling curves were obtained. It is doubtful whether ten plants are sufficient for comparative purposes, but any increase would render the work on hand too much to carry out.

The plots in this experiment suffered somewhat from hail damage, but not nearly so severely as the progeny row plot. The June-sown plots again suffered from attack of *Syagrus* sp., but the beetle grub was far less prevalent than in the preceding year. Table III. gives a summary of the results from these plots.

TABLE III.
YIELDS IN LBS. IN ALL CASES.

Sowing Date.	Mean Yield	4 by 2 feet (2 plants per hole).	4 by 2 feet (1 plant per hole).	4 by 1 feet (1 plant per hole).	3 by 2 feet (1 plant per hole).	3 by 1 feet (1 plant per hole).
June	Per Plot	14.46	15.29	16.85	17.67	19.93
	Calculated per acre	289.2	305.8	337.0	353.4	398.6
	*Per plant	0.09	0.07	0.06	0.08	0.06
	Per acre calculated from yield per plant	435	339	719	610	943
July	Per plot	15.25	14.15	16.65	14.19	15.92
	Calculated per acre	305	283	332	284	318
	*Per plant	0.09	0.09	0.06	0.05	0.04
	Per acre calculated from yield per plant	420	474	680	515	613
August	Per plot	10.96	10.60	11.31	13.57	12.88
	Calculated per acre	218	212	226	271	258
	*Per plant	0.05	0.07	0.04	0.07	0.04
	Per acre calculated from yield per plant	326	344	467	495	519

* In the case of spacing 4 by 2 feet, 2 plants per hole, the figures given for yield per plant are for yield per hole.

Looking at these results, it would appear that closer spacing and early planting give higher yields than wide spacings and late sowings, but a statistical examination of plot yields shows that the greatest difference between any two plots is within the limits of twice the standard error of the mean difference, and therefore is not significant. This result means that at least a 30 per cent. difference is necessary to be significant, and to reduce this a greater number of replications will have to be sown in field trials.

COMPARATIVE YIELD TRIAL OF NYASALAND STRAINS.

Three strains, Nos. 6, 19 and 24, were tested for yield against No. 17, each being repeated five times. The results summarized in Table IV. show no difference at all in total yield, and as none of these cottons shows any superiority over No. 17, they will not be increased in bulk for general distribution at present.

TABLE IV.
YIELDS IN LBS. SPACING 4 BY 2 FEET.

	No. 17.	No. 19.	No. 6.	No. 24.
Mean per plot	18.61	16.96	18.63	16.73
Calculated yield per acre	372	339	353	335
Mean yield per plant	0.09	0.08	0.08	0.08
Yield per acre calculated from yield per plant	445	400	400	400

RIDGING VERSUS FLAT CULTIVATION.

The normal native custom is to cultivate cotton on the flat, but as ridging is practised with success in other countries, it was decided to try the method in a field experiment; five plots of ridged and five of flat were planted with No. 17 seed, the spacing being 4 by 2 feet in both cases. The yields from both sets of plots were practically identical, and there is no point in tabling them.

The value of ridged cotton would appear to be improved drainage during the early stages of growth; later on the roots would be well below the surface and away from any influence the ridges could exert. Thus, in a season when much rain is experienced soon after planting it would be expected that ridged cotton would benefit. As 1926 was dry at the critical time, the results indicated above were obtained.

SIMSA PLANTATION.

There is a small Government plantation at Simsa, 25 miles from Serere, in charge of a native headman, but under constant European supervision. The soil is very poor and sandy, and despite a fairly high rainfall it suffers from drought; it is, therefore, very useful for conducting small experiments, the results of which would be applicable to such districts as Usuku, where similar conditions obtain.

In 1926-27 a spacing experiment was laid down with the following results, which show no significant difference at all:

TABLE V.

<i>Spacing.</i>	<i>Mean Yield per Plot (Lbs.).</i>
4 by 2 feet.	17.4
4 by 2 feet (2 plants per hole).	17.6
3 by 2 feet.	18.4
4 by 1 feet.	18.8
3 by 1 feet.	18.0

NGETTA PLANTATION.

There is another small Government plantation near Lira. It is under direct supervision of an Agricultural Officer, so that here experiments can be conducted with certainty that the results are accurate. In 1926-27 three experiments were commenced—two spacing trials and a comparative yield test of Nyasaland strains.

The spacing trials consisted in the comparison of four by two and three by one spacings, and of one plant per hole as against two. The results show slight indications that close spacing gives a higher yield, but no difference in yield between the one and two plants per hole.

STRAIN TRIAL.

Four strains, Nos. 6, 17, 19 and 24, were tested at Serere, and the results merely indicate that No. 6 may be slightly higher yielding than the other strains, though the differences are not statistically significant.

SPACING TRIALS IN OUTLYING PARTS OF TESO AND LANGO.

A number of small spacing trials were carried out in various parts of the above districts under supervision of native chiefs and trained native instructors, but the laying out, sowing, and first pickings of each experiment were supervised by a European. No reliance can

be placed on the accuracy of the results, but they will serve as a guide for future work, when it may be possible to get proper supervision for the whole period of the experiment. The figures of yields are given in the table below, as they form an interesting picture of the great variation in yields from different areas.

TABLE VI.
YIELDS IN LBS. (IN EACH CASE THE MEAN OF FIVE $\frac{1}{20}$ ACRE PLOTS).

<i>Site of Experiment.</i>					<i>4 by 2 feet.</i>	<i>3 by 1 feet.</i>
Teso						
Nyero	..	..	..	..	21.6	19.2
Tira	..	..	..	..	31.2	32.0
Labori	..	..	..	..	62.2	57.2
Katakwi	..	..	..	..	24.0	27.0
Lango						
Aduku	..	..	..	..	11.8	13.4
Dokolo	..	..	..	..	25.8	27.6
Kaberomido	..	..	..	..	18.0	13.2

All these plots were sown in July, and there is seen to be no indications of close spacing giving greater yields. The high yields from Labori are quite reliable, and show that given the right soil conditions, the cotton (No. 17) will give a very high yield.

KAMPALA PLANTATION.

A small test of two of the Nyasaland strains against the cotton in general distribution was conducted on this plantation, and very complete records were kept by the Plantation Manager throughout the season. Owing to lack of space, the size of plots had to be reduced, and they could be repeated only four times, the yields being given as per 200 plants.

The difference between the plot yields was not significant, but two interesting points emerge, first the very low germination of No. 17, which was confirmed in laboratory tests, and the second, that an inspection of the plot layout shows that the plots with a high proportion of second and third qualities cotton are nearest to a plot of ground which in the early stages of the experiment had been under several species of malvaceous plants; and that the bad cotton was chiefly due to stainers which must have come from these plants is confirmed by the following extract from the Plantation Manager's

report on the experiment: " Stainers in all plots noticeable November 13 to end of March. Period of greatest numbers, week ending January 15 and after March 12. Slight drop between these dates, most prevalent on plots 1, 2, 10, 11 and 12."

PLOT LAYOUT, KAMPALA PLANTATION.

*Malvaceous Plants.**

1	2	3	4	5	6
12	11	10	9	8	7

BUKALASA EXPERIMENT STATION.

A spacing experiment conducted here gave the results set out in Table VII. Again no results of significance were obtained.

TABLE VII.

Spacing.	Yield in Lbs. Mean of 4 Plots.		Total Yield per Plot.
	First Quality.	Other.	
4 by 2 feet	20.25	3.25	23.50
4 by 1½ feet	21.32	3.75	25.07
4 by 1 feet	23.87	3.62	27.49
3½ by 2 feet	21.62	3.37	24.99
3½ by 1½ feet	23.62	3.87	27.49
3½ by 1 feet	24.8	3.62	28.42
3 by 2 feet	21.75	5.25	27.00
3 by 1½ feet	22.06	5.36	27.42
3 by 1 feet	24.00	5.10	29.10

GENERAL.

Samples of seed cotton were received from most cotton-growing districts of the Protectorate, and were fully examined qualitatively and quantitatively. A summary of the quantitative characters is given in Table VIII. on p. 186.

The need for new seed at Masindi, S. Bugishu and parts of Busoga, is clearly seen, as the cotton is short-stapled and irregular in those districts.

* These plants were: *Hibiscus diversifolius*, *H. cannabinus*, *H. surrotensis*, *H. calyphyllus*, *H. rostellatus*, *Sida cordifolia*, *S. thombifolia*. They were uprooted and burned in November.

TABLE VIII.

<i>District.</i>	<i>Number of Samples.</i>	<i>Lint Length in Mms.</i>	<i>Weight (100 Seeds).</i>	<i>Lint Index.</i>	<i>Ginning Outturn.</i>	<i>Seed Purity Per- centage.</i>
Teso	9	28.42 ± 2.44	10.31	5.02	32.6	90.2
Lango	9	28.72 ± 2.36	10.23	5.19	33.6	88.1
Bugwere	8	28.17 ± 2.47	10.36	5.30	33.3	76.6
Budama	6	28.00 ± 2.33	10.59	5.35	33.9	71.0
Bugishu	(N) 2	28.32 ± 2.28	10.55	5.12	32.5	83.0
Bugishu	(S) 2	27.91 ± 2.84	10.08	5.29	34.4	59.0
Busoga	(old) 3	29.13 ± 2.15	10.33	4.99	32.6	68.0
Busoga	(new) 3	29.8 ± 1.68	11.25	5.69	33.6	97.0
Bulemezi	2	30.66 ± 2.16	12.10	5.40	30.8	98.0
Hoima	(old) —	27.54 ± 2.98	9.64	4.53	32.0	83.0
Masindi	(new) —	30.96 ± 2.16	10.91	5.13	31.9	96.0
Masindi	(old) —	28.96 ± 3.20	10.69	5.31	33.2	76.0

Over the whole area under examination the staple is rather on the short side, being well below $1\frac{3}{8}$ inches, which is the length aimed at.

The beneficial results obtained by the introduction of new seed (No. 17) into parts of Busoga are very noticeable, and the ginnerers in those districts are more than satisfied.

SULPHURIC ACID EXPERIMENTS.

The laboratory experiments of last year were repeated early in 1927, commercial acid being used in place of pure. The results were very much the same, the influence of the acid in increasing the percentage germination and the rapidity of germination being again very marked.

TABLE IX.

<i>Treatment.</i>	<i>Germination Percentage.</i>	<i>Days to Complete.</i>
Control	61	10
H ₂ SO ₄ (twenty minutes) floating seed	78.5	5
H ₂ SO ₄ (twenty minutes) sunk seed	88.9	4
Water soaked (twenty minutes)	72.0	5
H ₂ SO ₄ (twenty minutes) dried before testing	83.9	4

Owing to the possibility of the seed treatment having an effect on the subsequent growth and development of the cotton plant, it was decided to initiate a small field trial under normal conditions during 1927-28. Complete growth, flowering, and bolling records will be kept on these plants.

Four rows, each of 40 holes, were sown of each treatment, one seed only being sown per hole; the germination percentage of these rows is the only record yet to hand, and the mean for each treatment is given below:

<i>Treatment.</i>	<i>Germination Percentage (Mean of 4 Rows).</i>	
1. Control (no treatment)	51.7	} Sown on July 23.
2. Water soaked for twenty minutes immediately previous to sowing	62.4	
3. H_2SO_4 (twenty minutes). Treated three weeks before sowing, washed and dried	54.5	
4. H_2SO_4 (twenty minutes). Washed and sown immediately after treatment (sunk seed)	70.8	
5. H_2SO_4 (twenty minutes). As (4) but floating seed	55.4	

The increase in germination due to sulphuric acid treatment—when sunk seed is treated for twenty minutes and washed in water immediately previous to sowing—over the control and the two other acid treatments is significant.

If it is found that no deleterious after effects occur as a result of this treatment, acid will be very useful when only small quantities of seed are available and a good germination is necessary.

What this increase in germination indicates is rather obscure; it is possible that the extra seeds germinating are weakly ones giving rise to weakly plants. On the other hand, it is more probable that seeds with a great quantity of fuzz are able to get moisture more readily, whereas under ordinary conditions the fuzz prevents the seed getting sufficient moisture.

SUMMARY.

The climatic conditions of the season 1926-27 were generally unfavourable to the cotton plant, especially to boll production, and resulted in the complete failure of all progeny rows.

Jassid had a considerable effect in destroying the crop at Serere.

The four strains grown in increase plots remained true to type, and show promise as regards yielding powers, but the spinning reports are not encouraging.

Sulphuric acid treatment of seed again gave increased germination.

The results of spacing trials are rather disappointing, no one spacing showing a significant superiority over another, the probable explanation being the large number of monopodial branches which are the characteristic habit of growth of the Nyasaland Upland variety in this country.

APPENDIX I.

SPINNING TESTS ON NEW STRAINS.

The following is a summary of the results of the spinning tests on strains SG 15, SG 26, SG 27, and SG 29. These strains are from single plant selections made in 1925, which were grown in progeny rows in 1925-26 and in small bulk increase plots in 1926-27.

BROKER'S REPORT.

SG 15	Strict good middling, creamy in colour	$1\frac{3}{16}$ inches mixed with short	Medium to strong	Fine and lustrous	1
SG 26	"	$1\frac{3}{16}$ inches	"	Wanting in fineness and lustre	2
SG 27	"	$1\frac{1}{8}$ inches	"	"	4
SG 29	"	$1\frac{1}{8}$ inches to $1\frac{3}{16}$ inches	"	"	3

SPINNER'S REPORT.

Strain.	Nominal Count and Type of Yarn.	Amount of Twist given (Turns per Inch).	Total Waste Percentage.	Strength (Lea Test in Lbs.).	Work of Rupture (Inch Lbs. per Lea).	Actual Count.
SG 15 ..	58s twist carded	27.63	8.7	34.1	43.5	60.2
SG 26 ..	"	27.63	10.0	27.8	37.0	58.4
SG 27 ..	"	27.63	10.5	28.9	38.5	58.9
SG 29 ..	"	27.63	11.6	28.1	38.5	58.8
E. African (control) ..	"	27.63	10.9	26.7	36.3	58.9

Yarn Examination.—Order of merit judged from appearance on the blackboards:

1. E. African control.
2. SG 26.
3. SG 27.
4. SG 29.
5. SG 15.

SG 26 is nearly as good as the control, and would be superior but for one or two neps. SG 15 is rather neppy and uneven.

The arrangements for carrying out these tests were made by the Empire Cotton Growing Corporation. The thanks of the authors are due to the Liverpool Cotton Association and to the firm of brokers who examined the samples, and to the Cotton Research Association and the spinners who kindly carried out these spinning tests.

NYASALAND

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATIONS, SEASON 1926-27

INTRODUCTORY NOTE BY MR. H. C. DUCKER.

THE following report on Makwapala is by Mr. J. V. Lochrie, who was in charge of the cotton work at this station from January onwards, and of the whole work of the station from May onwards, in which month Mr. W. L. Miller, the Farm Manager, went on leave. The report on Port Herald is by Mr. E. Lawrence, who was in charge of the entire work of the latter station throughout the year under review.

It is a considerable pleasure, after two somewhat trying and disappointing years, to be able to report a good season in which some record results have been achieved. The fact of having exceeded the 200 lbs. of lint per acre mark at both stations is very gratifying, especially when one considers that the best result so far obtained on these stations is less than 100 lbs. per acre, while a very usual average Nyasaland yield is in the neighbourhood of 60 lbs. lint per acre. One's only regret is that the stations have not averaged over 200 lbs. instead of just reaching this figure on certain areas.

In addition to the station work a number of plots of strain B have been grown in various parts of the country. Unfortunately all the results are not yet to hand, but yields of approximately 130 lbs. of lint per acre at Liwonde and 230 lbs. lint per acre at Lisungwe have been reported. The former yield was obtained by Mrs. King, the wife of Mr. C. B. R. King, the Corporation's Entomologist, at her Liwonde Estate, and the latter by the only native to whom seed was issued, Chief Simon at Lisungwe.

Two plots at Luchenza were comparative failures owing to excessive rainfall in this area, while none of the Lower Shire plots of "Over the Top" have been very successful.

It is, however, to be hoped that the long staple Foster Whitehall, which is proving so successful at Port Herald this year, will continue to be so, and thus provide for the Lower Shire the particular variety best adapted to its conditions.

Samples sent home for spinning tests last year of the "Over the Top" strain B, together with representative samples of Nyasaland

Upland, gave results which indicate that this strain is quite as good as the ordinary run of Nyasaland cotton from the spinners' point of view, while, though it is not demonstrated clearly by this year's variety test at Makwapala, the bulk of evidence is in favour of the agricultural superiority of the "Over the Top." It is expected that it will be possible, within the next three seasons, to replace the present mixed bulk of the "Over the Top" strain B by a pure line selection superior to its parent.

One interesting result of the variety test is that it would appear to confirm the opinion of the B.C.G.A. that the Lisungwe stock of seed of Nyasaland Upland is the best large bulk available at present in the country. Since this stock represents some 10 per cent. of the total seed stocks available, any information of this nature is of value.

MAKWAPALA COTTON STATION, REPORT FOR THE SEASON 1926-27

BY

J. V. LOCHRIE.

Season.—The past season on the whole has been favourable to the growing of cotton at Makwapala. The rains broke early, and planting was completed in good time. A sufficiency of well-distributed falls occurred during the first month of growth, following which came a fine spell which enabled efficient intercultivation to be done and promoted a healthy root development. Subsequent rainfall was well distributed, with an abundance of sunny intervals, the last heavy shower falling on April 13, after which date the weather was very dry.

The period March 4-8 was marked by the occurrence of rain with a very high wind, the aftermath of a cyclone which reached its maximum severity somewhere off Madagascar. Apart from this spell there was nothing else in the way of bad weather which could damage the crops.

The cold weather, as indicated by the date when the mean minimum temperature began dropping below 60° F., set in fully a fortnight earlier this season than last.

It is interesting to compare this season, the best so far in the station's history, with that of 1924-25, which is easily the worst. The rainfall totals are practically the same, 37·87 inches as compared with 40·47 inches in 1924-25, and it seems evident that the difference is almost entirely a matter of the distribution.

General.—The work of the station has continued on the lines described in the 1925–26 Report.

The rotations were carried on into their third year, thus completing one cycle in the case of the three-course rotations and one and a half cycles of the two-course Cotton-Cereals rotation. With the exception of a Columbia strain called Arizona, supplied to Makwapala by Mr. Salter, E.C.G.C. Cotton Specialist, Northern Rhodesia, no new introductions of cotton were made.

Two of the three methods of checking soil erosion described last year were tried on a field scale, and such success was obtained by the use of ridge terraces that it has been decided to use this method on the whole station.

Additions are being made to the buildings in the shape of two small tobacco-curing barns, and a tobacco-bulking and grading shed, all of which it is hoped will be completed in time for the 1927–28 crop. These buildings will enable the tobacco crop grown in the Tobacco-Cotton rotations to be cured and generally dealt with on the station. The necessary capital expenditure is being met by the Department of Agriculture.

Additions to the implements used on the station consist of a Martin Terracer and Grader imported from the United States. This is proving a very useful implement for making the ridge terraces to check soil erosion.

A system of experiments with cotton has been inaugurated, embracing variety, cultural, and spacing trials, and the plant breeding work has been carried on as before. A small but fairly reliable staff of native observers has now been trained, and this season it has been found possible to accumulate considerable data in the form of continuous records such as were described in the 1925–26 Report.

Rotations at Makwapala.—The cropping scheme for this season was as follows:

	<i>Field.</i>	<i>Field.</i>	<i>Field.</i>
Rotation I.	1. Cereals	10. Cotton	—
„ II.	2. Cotton	11. Cereal-pulse	8. Tobacco
„ III.	3. Cotton	12. Fibres	7. Cereal-pulse
„ IV.	4. Oilseeds	5. Cereal-pulse	6. Cotton

Miscellaneous Block: Field 9, Miscellaneous crops and cotton-breeding plots.

The rotations as described in previous reports are thus carried on into their third season. Though it is still rather early to expect a great deal of information as to the effects of these rotations, certain observations have now been made which indicate the advisability of several modifications being made next season. These will be noted in the body of the report as they occur.

ROTATION I.: COTTON, CEREALS.

Field 1: Cereals.—This field was sown with the four main cereals of the country, one quarter with each cereal. The layout was the same as that in 1924-25, except that the Maweri and Maize changed places. This was done to remove the maize from the vicinity of a public road, where it was a temptation to the natives passing by.

Maize (Zea mays).—This plot was sown with the variety, Potchefs-troom Pearl, imported from the Transvaal, which was grown as a seed plot in Field 9 last year.

Sowing was done on December 10, 1926, at a spacing of 4 by 2 feet, three seeds per hole, and later thinned to two plants per hole. A good stand was obtained. This strain did not make so large a growth as was made by the other maize fields on the farm, but it was observed to contain a particularly high percentage of two-cob plants. Harvesting was commenced on April 5, a yield of 3,340 lbs. on the cob per acre being obtained, approximately 2,505 lbs. grain per acre.

Mapira (Sorghum vulgare).—The variety sown was Sumbwi, as before, drilled in 30-inch rows at 8 lbs. per acre and later thinned to 9 inches in the row. A fair stand was obtained, but growth was not very good owing to the root parasite *Striga coccinea*. Reference to this pest is made below. Harvesting was commenced on March 23, the yield of grain being 1,000 lbs. per acre.

Macheweri (Pennisetum typhoideum).—The variety sown was the same as in 1925-26. Sowing was done on December 3, 1926, the seed being drilled in 30-inch rows at the rate of 6 lbs. per acre. Thinning was done later to 9 inches in the row. A good stand was obtained, and the crop tillered well. Harvesting was commenced on March 23, the yield of grain obtained being 1,200 lbs. per acre. It would appear that, for this season's conditions, a closer spacing might have been adopted with advantage.

Maweri (Eleusine coracana).—This plot was sown with selected seed from the 1925-26 crop. Planting was done with seedlings behind the plough on January 5, and a moderate stand was obtained. Tillering was, however, very good indeed, and a fair yield was ultimately obtained of 1,846 lbs. grain per acre. All the cereals in this field were attacked by Rooibloem (*Striga coccinea*), a root parasite which was particularly prevalent on the Mapira and the Macheweri. Elsewhere on the station this parasite has not reached anything like the same proportions as a pest, and it seems evident that one year's interval between cereal crops is insufficient to allow of its control.

It has therefore been decided to plant half the cereal area in this rotation with a pulse crop in the future, thus converting the rotation into a four-course—Cotton-Cereal-Cotton-Pulse, the pulse and cereal breaks alternating each cycle.

Field 10: Cotton.—The variety grown was “Over the Top,” strain B, as grown in Field 1 last season.

Planting was done on December 15 at a 4 by 2 feet spacing, 12 lbs. of seed being sown per acre. On January 11 the field was thinned to two plants per hole. Cultivation was on the flat throughout.

The first flower was observed on February 8, and a week later flowering was general.

In this field at no time was Stainer (*Dysdercus*) observed in any effective numbers, and though bollworm accounted for much of the early crop the field was much freer of pests than any other cotton on the station. The whole season this field had a markedly healthier appearance than others of the same strain of cotton. Internal boll disease was present to a small extent only, and the crop remained very free of Jassid.

The stand obtained was fairly satisfactory, 63 per cent. of the total possible number of plants at the spacing (all stands were calculated, where two plants were grown at a 4 by 2 feet spacing, on the basis of one plant per row foot).

Picking commenced on April 29, and was completed by June 26, the yield per acre being 705 lbs. clean seed cotton and 25 lbs. of dirty seed cotton. This was by far the highest yield recorded on the Station, but it is doubtful how far this is due to its place in the rotations. As this was the only cotton field which had been ridge-terraced to check soil erosion, it seems very probable that much of the increased health and productivity is due to the better soil conditions. It will be noted later that where wash had been considerable a negligible yield was obtained from such areas.

It is of interest to note that the above yield, which represents 222 lbs. clean white lint per acre (strain B gins 31·5 per cent. approximately), is the highest yield yet recorded at Makwapala.

ROTATION II.: COTTON, TOBACCO, CEREAL-PULSE.

Field 2: Cotton.—Approximately half of this field was sown with a bulk of strain B as for Field 10. Sowing was done on December 14, and thinned later to two plants per hole. The seed rate here was 10 lbs. per acre. The remainder of the field was used for the spacing experiments and variety trials, a full description of which appears later in this report. The stand obtained of the bulk was not good—

40 per cent. of the possible total—and the plants lacked the healthy appearance of Field 10. Early in the season Stainer (*Dysdercus* spp.) appeared in considerable numbers. It may be noted that this field suffered from wash.

Picking commenced on May 4 and was completed on July 1, the yield obtained being 312 lbs. clean seed cotton per acre and 45 lbs. per acre stained seed cotton.

Field 11: Cereal-Pulse.—This field was sown half with Florida Bush Velvet bean (*Stizolobium* sp.) and half with maize.

The Bush Velvet bean was planted on December 11 at a spacing of 20 by 12 inches. Germination was good, and the crop made a fair cover in about four weeks' growth, which, however, did not compare for density with the running sort planted in Field 9. The crop was harvested for seed on April 6, a yield of 1,125 lbs. being obtained per acre. It may be noted that this crop showed a tendency to sprout from the pods when in the field, owing to the fact of its being so low on the ground. This might give rise to considerable difficulties in a wet year, unless a later time of planting were adopted.

Maize.—The seed used was Potchefstroom Pearl, imported by the Department of Agriculture from Rhodesia, and grown at Makwapala in 1925-26. Sowing was done on November 26, at spacing 4 by 2 feet, four seeds per hole, and three weeks later the crop was thinned to two plants per hole. Growth was good, though rather patchy on one anthill.

Harvesting was commenced on March 25, a yield of 4,070 lbs. on the cob per acre being obtained.

It may be noted, as further showing the value of ridge-terracing, that this, the highest yield of maize on the station, was grown on land so treated.

Field 8: Tobacco.—This was planted on December 28 with Hickory Prior, the seed being obtained from the crop grown at Makwapala in 1925-26. Half the field was spaced 3 by 3 feet and half 4 by 2 feet. Only a fair stand was obtained, and growth was irregular owing to the various supplyings which were necessary. Later the crop came on well, and in spite of the heavy wind in early March was very promising at the time of harvest. All cultivation was on the flat. The tobacco crop in the district was a very heavy one this year, and it was impossible for some time to get accommodation for curing. The crop was cured eventually by courtesy of Mr. Thorneycroft at his Tengarangilu Estate, but by then part of the crop was overripe and lost. At the present time barn accommodation is being erected on the station for the handling of this crop, and this season's difficulty should not

occur again. The ultimate yield was approximately three hundred-weight of cured leaf per acre, which was, however, rather mixed as to grade on account of the delayed harvesting. This rotation appears to fit very well into the European planter's cropping schemes, and it is proposed to carry it on through yet another cycle.

ROTATION III.: COTTON, FIBRES, CEREAL-PULSE.

Field 3: Cotton.—This field was sown with strain B as for Field 10. Sowing was done on December 13, at a seed rate of $8\frac{1}{2}$ lbs. per acre. The stand obtained was extremely poor—32 per cent.—and the plants did not thrive well, the patchy appearance being in a great measure due to the considerable washing of the soil.

The first flowers were observed on February 7, and picking commenced on May 5. The yield per acre obtained was 225 lbs. clean seed cotton, and 50 lbs. per acre stained. As in Field 2, which adjoins it, this field was heavily attacked by bollworm and stainer.

It is interesting to compare the seed rate with the stand obtained. It is noticeable that the stands obtained in Fields 10, 2, and 3 were successively less with the corresponding lowering of the seed rate. Consequently, for the next season, now that ample seed is available, it has been decided to give a uniform seed rate of at least 20 lbs. per acre. This, combined with the ridge-terracing of all the fields, should give more satisfactory stands.

Field 12: Fibres.—The only fibre sown this season was Sunn hemp. This, as described previously (1924-25 Report), has very many advantages as a rotation crop. Jute, which offers many serious objections, was not planted.

The Sunn hemp seed was broadcasted at 50 lbs. per acre on November 20. Owing to the dry conditions, germination was slow, but with the rains which fell later a full stand was obtained by December 9 without the need for any supplies.

The growth was not quite so good as in previous years, owing to the lack of any continuous wet weather, but was, generally speaking, quite fair, and some very nice fibre samples were extracted. The crop was harvested for seed on May 12, the seed heads being removed for threshing, and the stalks bundled and stooked in the field to be used as required.

Last season samples were harvested at various periods of growth, and it appears from reports furnished by Messrs. Wigglesworth that the best fibre is obtained by pulling and retting about the middle period of seed production, roughly when the lower half of the seed heads have set seed and the upper half are still flowering. The crop

this year was harvested at this stage, and rettings have yielded an excellent fibre. The yield of seed obtained was about 600 lbs. per acre.

With the development of the Native tobacco industry, it has been decided that a rotation embracing cotton and the type of dark tobacco grown by the native is desirable. Sunn hemp in Rotation III. is therefore being replaced by dark tobacco, and the fibre rotation is being telescoped into Rotation IV., embracing the oilseeds. This will also reduce the amounts of fibre and oilseeds grown to more manageable proportions; neither have much market, and under the old rotational layout have tended to a certain amount of waste.

Field 7: Cereal-Pulse.—This field was sown half with maize and half with *Dolichos Lablab*.

Maize, sown on December 10, was the same strain as that sown in Field 11, and received the same treatment, except that it was on contour drained land, and not on ridge-terraced land. The yield obtained was 3,200 lbs. per acre on the cob.

Dolichos Lablab: This pulse was sown on December 13 at a spacing of $2\frac{1}{2}$ by 2 feet, and in three weeks commenced to form a very good ground cover. The crop was attacked by a root parasite rather like that on the cereals in its habits and growth, but unlike it in form. It has been provisionally identified as *Electra* sp., but may be a *Rhinanthus*. The crop did not suffer greatly, though the parasite was severe in its effect on certain plots of *phaseolus* in Field 9.

Insect pests noted on the *Dolichos* included a Bruchid beetle and a Cantharid beetle, which did a considerable amount of damage to the flowers. The damage to the seed crop, as the result of these pests, must have been severe. The crop is not, however, harvested at the time of writing.

Three varieties of *Dolichos* were grown in the field differing from one another in seed colour only. The seed colours were brown, black, and white, and the strains appeared to be throwing true.

This appears to be a valuable cover crop, owing to its long duration and the large amount of leaf material it sheds. It is reported as gaining in popularity in Southern Rhodesia.

ROTATION IV.: COTTON, OILSEEDS, CEREAL-PULSE.

Field 4: Oilseeds.—This field was sown half with sesamum, and the rest with two varieties of groundnuts, one quarter to each variety.

Sesamum.—This was sown broadcast on February 16 at 5 lbs. per acre. Early germination was poor, but the crop thickened up later, and a good stand was obtained apart from one or two lines of wash. Harvesting was complete by June 20, the yield obtained

being 356 lbs. per acre. This yield, though better than last year's, is still low. The question of abandoning sesamum as a field crop is being considered. It is a difficult crop to market in Nyasaland, the only buyer offering to take it wanting 10-ton lots as a minimum.

Groundnuts.—As in 1925-26, two varieties were grown, Spanish bunch and the native variety, Chimbuwila. Both were sown on December 23 at 50 lbs. shelled nuts per acre, spacing the holes approximately 10 by 10 inches.

The Spanish bunch again showed its disadvantage of germination of some of its nuts before harvest, but the ultimate yields were satisfactory—Spanish bunch 1,410 lbs. per acre, Chimbuwila 1,060 lbs. per acre, both unshelled. The Spanish bunch has now shown a slight superiority in yield for two years over the Chimbuwila.

Field 5: Cercal-Pulse.—One half was planted with maize, as for Field 7 and Field 11, and the balance with a native variety of pigeon pea (known as *Mtundu wa Angulu*). The pigeon pea, contrary to usual Nyasaland practice, was grown as a close-spaced annual, and gives promise of being a valuable addition to the long-term pulses on the station. It was drilled in 30-inch rows, and left unthinned. It is being harvested at the time of writing. It appears that a certain amount of thinning might be beneficial, and spacing at 9 inches in the row will be tried next season.

The maize did not give so good a stand as that obtained on Fields 7 and 11, and in spite of the advantage gained from being on ridge-terraced land only gave 2,285 lbs. per acre on the cob.

Field 6: Cotton.—This field was sown with strain B as for Fields 10, 2, and 3. It is easily the worst piece of land on the station, fully a third being grey dambo, which produced plants about a foot high with scarcely any flowers or bolls. The stand on the best part of the field was good, and the yield as a whole averaged 59 per cent. of the possible total. In February the crop looked promising, but later bad bollworm attack was experienced and much stainer appeared subsequently. The yield per acre over all was 219 lbs. clean seed cotton and 29 lbs. dirty seed cotton, but this was obtained from barely two-thirds of the area and is hardly a fair indication of what the best part of the field yielded.

Miscellaneous Block, Field 9.—This area was used in part for the cotton-breeding plots, and in part for small observation plots of various rotation crops, mainly pulses. The cottons will be dealt with later in the report.

Among the small seed stocks of miscellaneous rotation crops were: pigeon pea (*Cajanus indicus*), a Kenya type which appears to

have the advantage of maturing all the pods on the plant about the same time; two varieties of sun-flower (*Helianthus annuus*); a climbing form of Velvet bean which is probably the same as the white stingless variety from Rhodesia, and promises well as a cover crop; and different varieties of phaseolus. All these crops have possibilities which may be utilized in the future.

SOIL EROSION.—Much has been said here and in earlier reports about the difficulties arising from soil erosion, and the importance of this subject. As was indicated in the last report (1925-26), three methods of checking this trouble were tried out this year.

Of these three methods those of ridge terraces and of contour drains both proved satisfactory with, however, advantages in favour of the ridge terraces, which, when once made, need no upkeep. The third method, that of strips of permanent vegetation, though not effective by itself, promises to be a very useful addition to the ridge terraces for planting up the field sides, and so protecting the points of outfall from the ridge terraces into the side drains.

It has been decided accordingly to ridge terrace the whole station. and this work has been greatly facilitated by the importation of a Martin ridge terracer from the United States of America. This implement is bullock-drawn, and very efficient in making a ridge, provided, however, that it is assisted by breaking the soil to be ridged by means of a previous ploughing.

With the aid of ridge terraces and the accompanying strips of permanent vegetation along the field sides the soil conditions will be stabilized on the station, and the loss of fertility and complications generally resulting from the soil erosion of the past will be avoided. In addition, the station will form an excellent object-lesson on a considerable scale of how to deal with land subject to erosion.

Instead of dub grass the building block is being planted up with Kikuyu grass, a stock of which was obtained from Kenya. This is a much more valuable grass, and far less trouble to control than the dub.

Some of the drains on the station have given trouble owing to their being, in some cases, on too great a slope. To prevent the consequent scour, and to obviate any further difficulty, it is intended to alter the type of the drain from a steep-sided to a wide shallow one, and when doing so, to plant up the drains with permanent vegetation; Msengere Grass (*Pennisetum* sp., Napier Fodder) will be used as for the field borders.

In dealing with the drains, work will be started at their heads and the alterations extended down the drains as the grass planted

becomes firmly established. Where roads cross the drains, permanent culverts are being built.

FIELD EXPERIMENTS.—As mentioned above, under “Rotations,” part of Field 2 was reserved for field experiments. These experiments comprised a number of spacing trials, a comparison of “Flat” and “Ridge” cultivation, and a variety trial.

The type of plot arrangement adopted was an adaptation of Dr. Beaven’s “half-drill-strip” method. This arrangement was described by Messrs. Engledow and Yule in the *Empire Cotton Growing Review*. As was demonstrated, in addition to sundry practical advantages, this method allows for variation in conditions operating across the plot layout, since in each pair of plots the variant under test is alternately to the right or left of the standard with which it is compared. A standard row width was used for the whole series of plots, and the same control was used throughout—viz., strain B sown 4 by 2 feet, one plant per hole. The half-drill strip forming each plot consisted of five rows, 55 feet long-trimmed to 54 feet at harvest. To facilitate the work, the rows were sown from end to end of the field in continuous lines, and thinned later to the required distances for each series of plots. Strain B, as sown in the Bulk fields of the rotations, was used throughout the plots. In the variety test this strain was compared with a Nyasaland Upland strain supplied by the B.C.G.A.

Six replicates were used of each variant in each experiment, each with its standard, giving a total of twelve plots per experiment. Sowing was done on December 14, and a good stand obtained over the whole area. Except for a certain amount of trouble from wash, conditions were uniform over the whole experimental area.

Ridge and Flat Experiment.—The usual method of cotton cultivation in Nyasaland, until the arrival of Mr. Sampson, was to plant the seed on a hoed ridge which was earthed up when the crop was cultivated. The method adopted at Makwapala, at the instance of Mr. Sampson, was to plant and cultivate entirely on the flat.

This experiment was designed to test the relative values of the two methods. A standard spacing of 4 by 2 feet, one plant per hole, was used, the only difference between the plots being that one set was planted on a small ridge which was kept earthed up throughout the season, while the other set was sown and cultivated on the flat. Strain B was used for both series. The results were not thoroughly conclusive, but there was some evidence in favour of cultivation on the flat.

Spacing Experiments.—The following are the list of spacings under trial:

				<i>Plants per Acre.</i>
A.	4 by 2 feet ..	..	Two plants per hole	10,890
B.	4 „ 1½ „ ..	..	One plant per hole	7,260
C.	4 „ 1½ „ ..	..	Two plants per hole	14,520
D.	4 „ 1 „ ..	..	One plant per hole	10,890
E.	4 feet by 6 inches ..	..	One plant per hole	21,780

The control used throughout was a spacing of 4 by 2 feet, one plant per hole.

In none of the trials did the spacing under test show any significant difference in yield from that of the control.

Observations made on the “Ridge” and “Flat” and “Spacing” Plots.—Plant height : Measurements of plant height were carried out through the season, and Table I. gives the mean height of the various plots at the time when picking commenced. The means are those of 100 plants in each case.

TABLE I.

Standard 4 by 2 ft. One plant 89.0 cm.	4 by 2 ft. Two plants 94.5 cm.	4 by 1½ ft. One plant 96.2 cm.	4 by 1½ ft. Two plants 99.8 cm.	4 by 1 ft. 94.0 cm.	4 ft. by 6 in. 94.7 cm.	Ridged 4 by 2 ft. 88.7 cm.
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The standard and ridged plots presented a similar appearance all through the season as regards development, and it is difficult to account for the possibly significant difference in yield in favour of the flat, except on the grounds of moisture conservation. Even this explanation seems inadequate, having regard to the equally green and leafy appearance maintained by both sets of plots right to the end of the season.

The plots spaced 4 by 2 feet, but with two plants left per hole, developed a decided asymmetry of growth. Where a full stand was obtained a decided suppression of monopodial branches was observed, and these grew at a more acute angle to the main stem than is usual with this strain in wide spacing. It may be noted here that the strain B of the “Over the Top” as grown on the station, has, so far as the unselected bulk is concerned, an undesirable branching habit. Generally the monopodials grow out at a wide angle from the stem, and when weighted with bolls on the secondary sympodia, these branches often break off. This is one of the points receiving attention in the breeding work. In both the two-plant per hole spacings and the closer spacings this tendency to branch was restricted. With

the two plants per hole it was observed that practically all the crop was carried on the more exposed sides of the plants, and that in many cases partial suppression of one plant by its fellow occurred.

As will be seen from the table of heights (Table I.), the series of plots with two plants per hole were much taller than the standard, the internode lengths being visibly greater. Neither of these two spacings showed any significant superiority to the standard, due probably to the obviously greater severity of bollworm attack, and of stainer-carried bollrots. At spacing 4 by $1\frac{1}{2}$ feet, with a single plant per hole, the plants were early remarked for their more upright and compact habit, coupled with relative freedom from bollworm and stainers.

Spacing, 4 by 1 foot: The same observations apply to the 6-inch spacing as to this and to an even greater degree. Early in the season the plants became leggy and straggly, the 6-inch spacing in particular showing nearly complete suppression of laterals. All the closer spacings suffered from the high wind which occurred in early March, and by mid-March these spacings and the two plants per hole had a jungly appearance completely locking in the rows. Bollworm attack was, with these spacings, particularly heavy on the early crop, practically all the cotton picked having come from the top crop and from the secondary sympodia.

Owing to the lack of a sufficient number of trained observers, it was found impossible this season to obtain continuous flowering and bolling curves from the spacing plots. It may be possible to remedy this next season with the increased native staff now available.

The decline of productivity across the line of plots was striking, and it is to be hoped that when these plots are repeated next season on ridge-terraced ground the more uniform conditions so obtained will provide data more easy of interpretation.

Finally, from the evidence of plant diagrams and general field observations, it seems certain that even with a season of not excessive rainfall as this has been the plants in close spacings are more heavily attacked by bollworm.

VARIETY TRIAL.

As mentioned above, a variety trial was carried out, using the same type of plot layout as for the Spacing, and Ridge and Flat Experiments. The "Over the Top," strain B, was again used, and with it was compared a Nyasaland Upland strain obtained from the B.C.G.A. This strain was derived from a bulk of native-grown

cotton at Lisungwe, and is probably the best strain of Nyasaland Upland in the country which is available in large bulk.

A spacing of 4 by 2 feet, one plant per hole, was used for standard and variant.

The middle row of each plot was used as the material from which the continuous records were obtained. These records consisted of daily flowering, bolling, and bollworm infestation records, and weekly measurements of heights, all of which were collated in conjunction with the continuous meteorological data obtained. Twenty-five plants were kept under observation in each plot, a total of 150 plants of each of the two varieties.

The yield, either from four rows of each plot or from the numbered observation plants in the middle row of each plot, showed no significant difference.

Continuous Records.—As stated, the material used for these records was obtained from the variety tests of strain B, and B.C.G.A. Nyasaland Upland, Lisungwe stock. The following records were kept:

- (a) Flowers opening per plant per day.
- (b) Bolls bursting per plant per day.
- (c) Buds, flowers, and bolls attacked by bollworm. Daily losses.

(It was found impossible to keep separate records of buds, flowers and bolls attacked, so that (c) gives merely the inclusive number, and is termed "bollworm infestation." Periodic examination of sheddings were made throughout the season.)

- (d) Growth in centimetres measured weekly.
- (e) Weekly collection of bollworm-infested material.

(e) was made from the adjacent bulk of strain B in the same field. The larvæ obtained from this collection were sent to the Corporation's Entomologist for identification and classification.

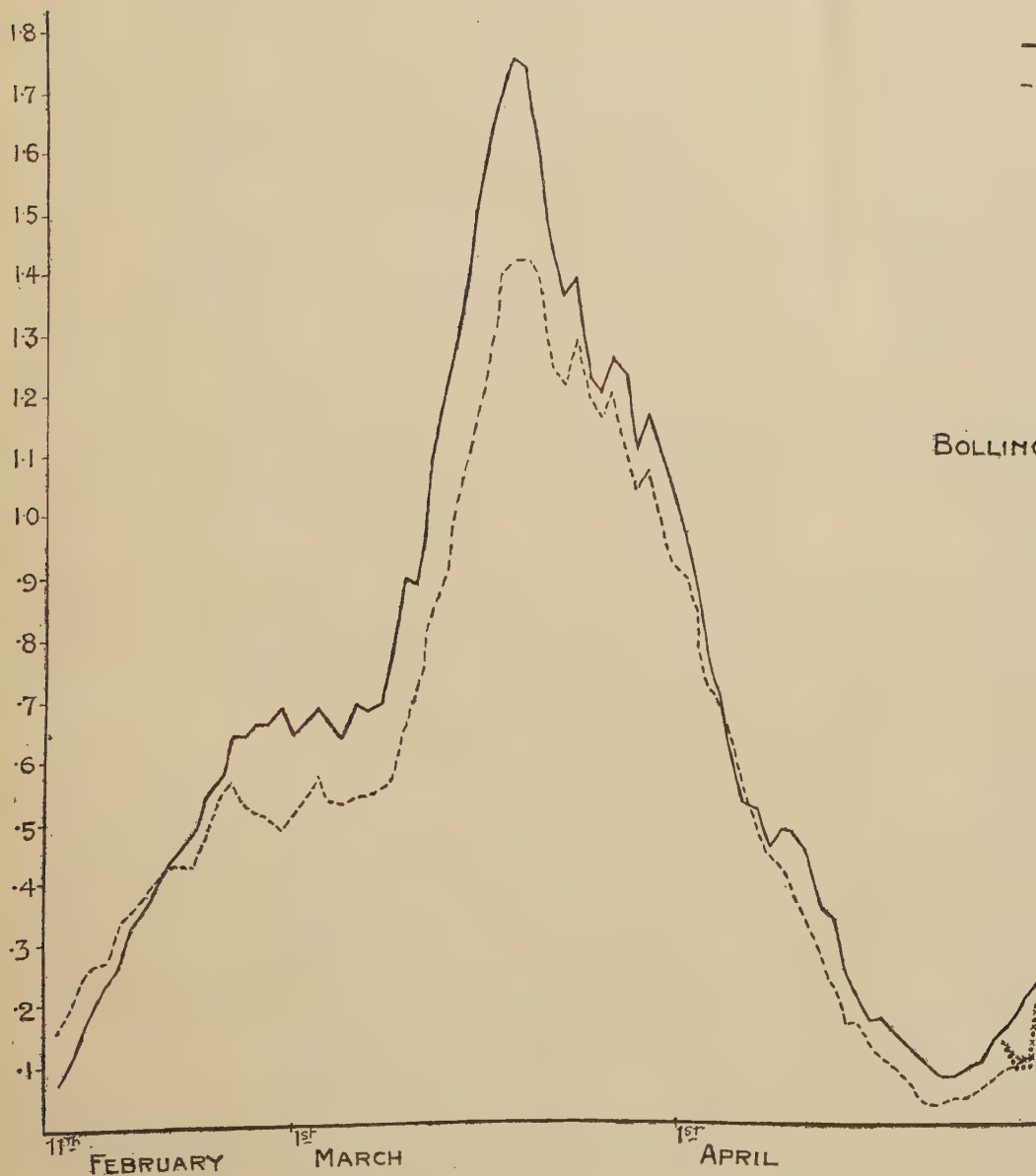
In flower production strain B gave higher totals than the Nyasaland Upland, and its loss from shedding was also somewhat smaller.

Flowering Curve (Fig. I.).—It is obvious from the curve that effective flowering ceased this season by the end of April, the rapid falling-off coinciding with the lowering of the night temperatures and to some degree with the end of the rains. Fig. V. shows that growth ceases at the same time, and it is probably this factor which determines the final shape of the flowering curve.

A few rows of plants have been left for observation in Field 9, but so far (October 18) no flowering has been observed. It is

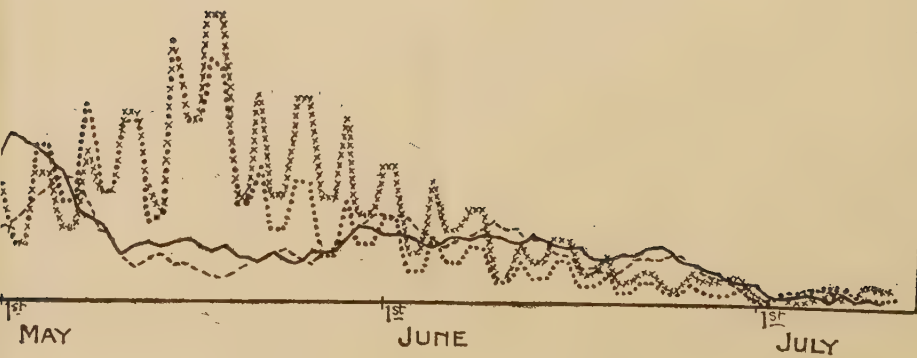
FIG 1.

MAKWAPALA.
FLOWERING CURVES PER PLANT P



ER DAY — 5 DAY MEANS.
—— NYASALAND UPLAND.
----- STRAIN "B"

CURVES PER PLANT PER DAY 5 DAY MEANS.
xxxxxxxxx NYASALAND UPLAND.
..... STRAIN "B".



MAKWAPALA

FIG. II. BOLLWORM INFESTATION CURVES PER PLANT PER DAY — 5 DAY MEANS.

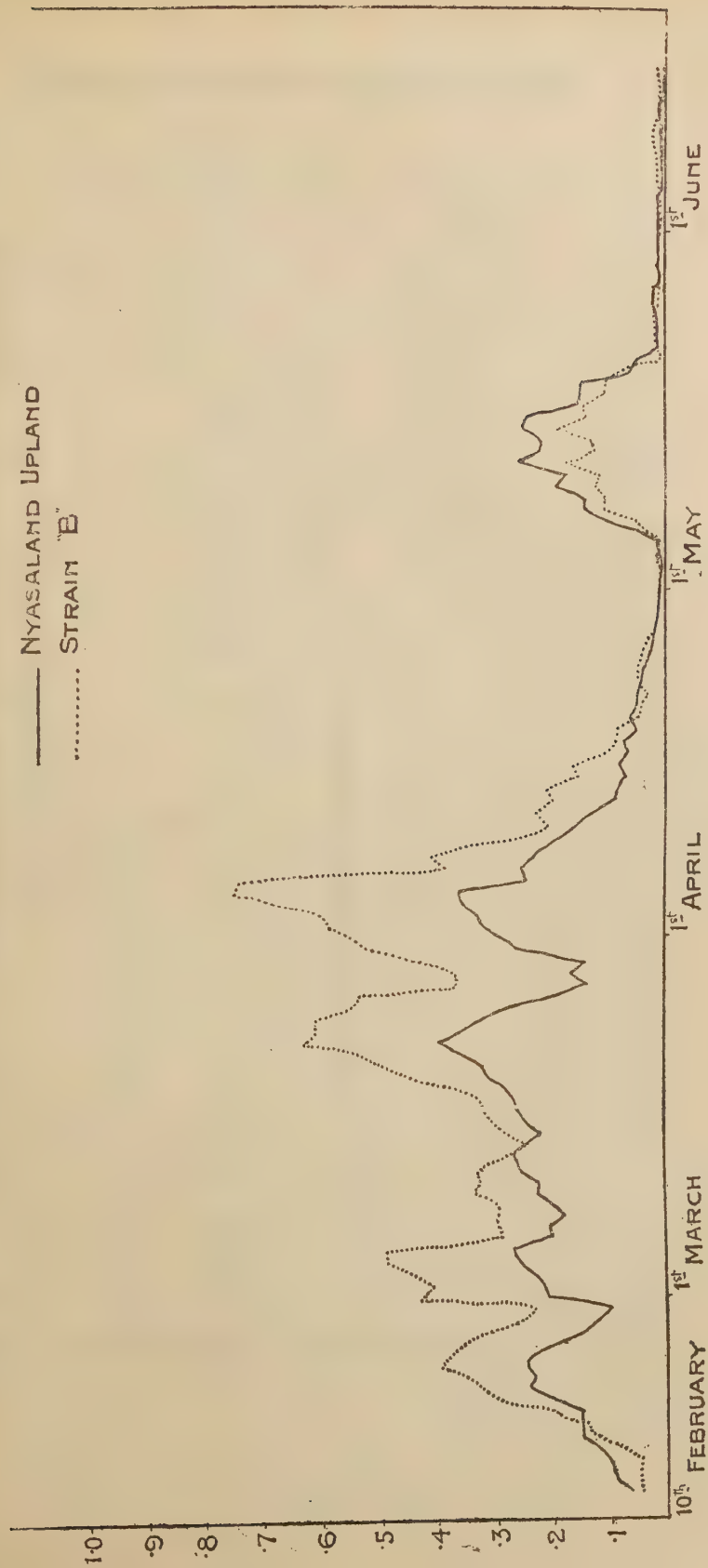


FIG III.
MAKWAPALA.
WET AND DRY BULB TEMPERATURES (9AM DAILY).

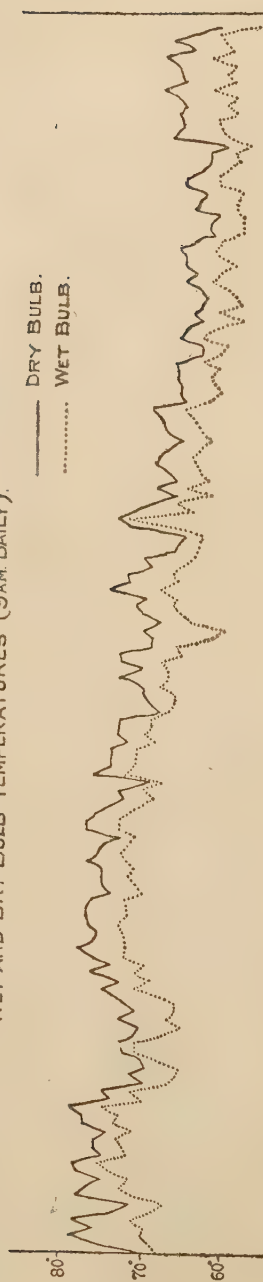
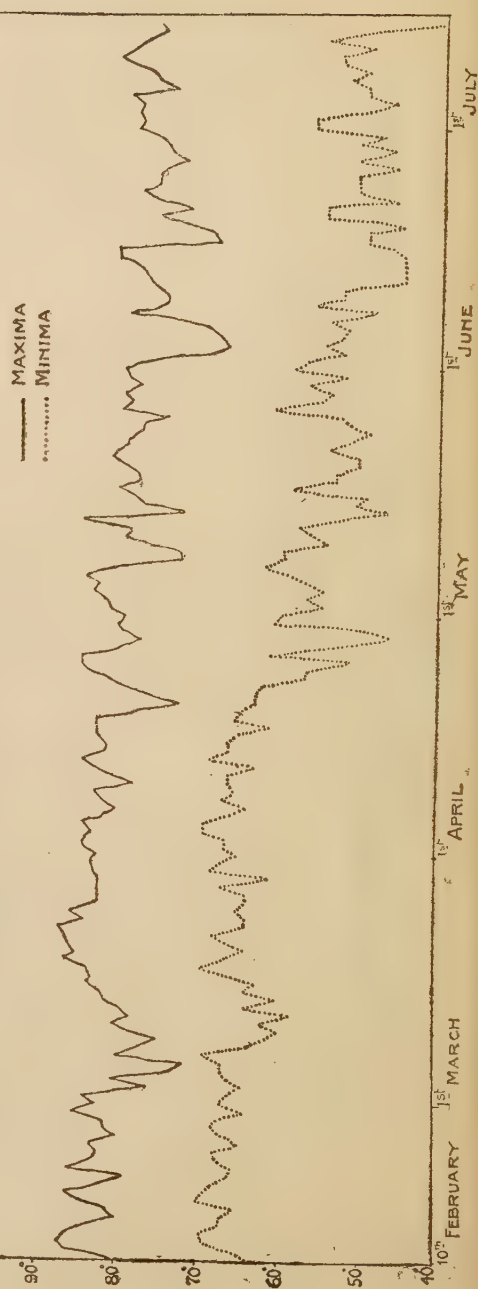


FIG. IV.
MAXIMUM AND MINIMUM TEMPERATURES - DAILY.



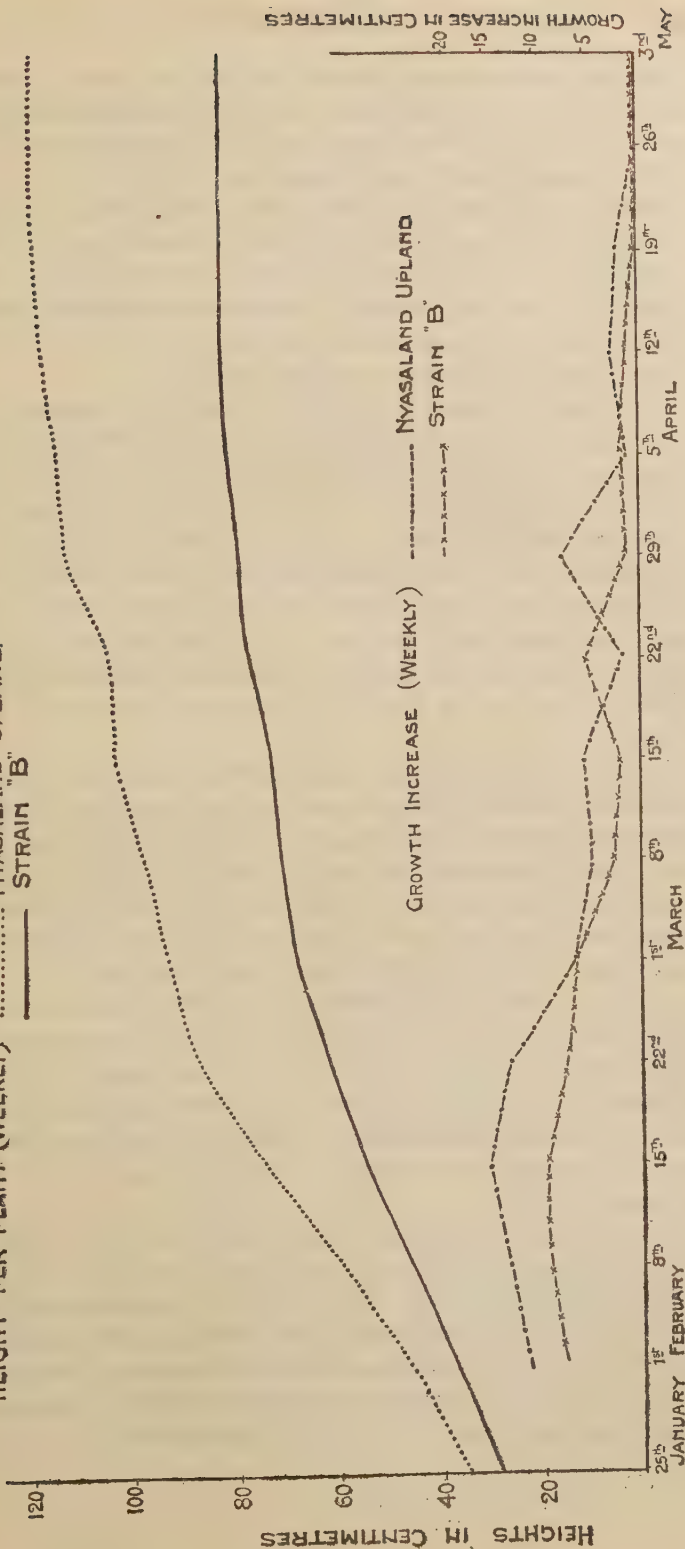
MAKWAPALA.

FIG. V

HEIGHT PER PLANT (WEEKLY)

..... NYASALAND UPLAND.

—— STRAIN "B"



difficult at present to say whether the limiting factor is lack of soil moisture or low night temperatures, but it is obvious that the final yield under the conditions prevailing this past season was dependent on the February-April flower production.

With the exception of a few days at the beginning of the season Nyasaland Upland gave the higher flower production.

Bolling Curve (Fig. I.).—The losses between flowering and bolting are very high, the proportion of bolls to flowers being 15.4 per cent. for strain B, and 17.5 per cent. for Nyasaland Upland. There is no significant difference between the final yields.

Bollworm Infestation (Fig. II.).—Losses due to bollworm form the most important limiting factor to cotton production. Strain B shows a heavier infestation, but there would appear to be no significant difference between the two varieties. It was noted that strain B appears to lose most heavily in flower buds, and the discrepancy between the two flowering curves is possibly explained by this. It is thought that there may be some varietal difference in the attractiveness of the strains for the bollworms, the difference being in the flower buds. It is already known (*vide* King's account of the Red Bollworm, *Empire Cotton Growing Review*) that the buds contain the attractive material.

Table II. gives an analysis of the shed material collected from between the rows of an adjacent bulk plot at various intervals. This would appear to show that this season, by the time flowering was profuse, the amount of shedding due to causes other than bollworm attack was the heaviest drain on the yield. In a comparison of the total shedding from all causes Nyasaland Upland showed a greater loss, which is probably statistically significant.

Table III. shows the numbers of red bollworm moths caught during the season. No systematic collections were made, rewards being offered for moths brought to the farm manager, on the lines suggested by Mr. King, the Corporation's Entomologist. The figures probably reflect the numbers present on the dates given. The gradual increase throughout the flowering season is distinctly interesting.

Pickings of bollworm-infested material were made on the bulk in Field 2 adjoining the plots, and the larvæ collected were identified and classified by Mr. King. Table IV. gives the analyses of the weekly pickings. The importance of the red bollworm is clearly shown.

This season the American Bollworm was found on maize, and particularly on tobacco flower heads, and its disappearance from the weekly analyses given in Table IV. coincides with the removal of

these crops. It seems possible that the presence of numbers of tobacco seed heads should be enough to keep this pest away from the cotton. As an indication of how prevalent it was on tobacco it may be noted that Mr. Miller, in examining some score of tobacco seed heads kept in Field 8 for seed purposes, found over fifty larvæ of this bollworm.

Neither the American nor the Spiny Bollworm has been of importance to cotton this season.

TABLE II.
ANALYSIS OF SHED MATERIAL.

<i>Date.</i>	<i>Attacked by Bollworm.</i>			<i>Not Attacked by Bollworm.</i>		
	<i>Buds.</i>	<i>Flowers.</i>	<i>Bolls.</i>	<i>Buds.</i>	<i>Flowers.</i>	<i>Bolls.</i>
3/3/27	5	1	74	—	—	—
14/3/27	7	—	13	2	—	79
28/3/27	3	—	21	1	—	61
11/4/27	2	—	40	—	—	76

NOTE.—“ Flower ” refers to a flower on the day of opening. Most of the bolls attacked by bollworm were two to three days old. The non-attacked shed bolls also belonged mainly to this class, though there were a few up to twenty-one days old.

TABLE III.
CATCHINGS OF RED BOLLWORM MOTHS.

	<i>Males.</i>	<i>Females.</i>	<i>Totals.</i>
December	1	4	5
January	1	3	4
February	7	25	32
March	28	30	58
April	163	120	283

It is interesting to note the great dissimilarity between this season's figures and those of the catches made in the 1925-26 season, as reported in this volume last year. It cannot be said that there is any indication whatever that the moth catching is having any effect on the bollworm population on the station.

TABLE IV.

ANALYSIS OF BOLLWORM POPULATION, WEEKLY COLLECTIONS.

Red Bollworm (*Diparopsis castanea*)=R.B.W.American Bollworm (*Chloridea obsoleta*)=A.B.W.Spiny Bollworm (*Earias* sp.)=S.B.W.

Date.	R.B.W.	A.B.W.	S.B.W.	Date.	R.B.W.	A.B.W.	S.B.W.
28/1/27 ..	23	—	—	29/4/27 ..	19	—	—
4/2/27 ..	58	2	6	6/5/27 ..	33	—	—
11/2/27 ..	26	2	6	13/5/27 ..	34	—	—
18/2/27 ..	19	1	3	20/5/27 ..	19	—	—
25/2/27 ..	32	—	—	27/5/27 ..	No collection		
4/3/27 ..	67	—	—	3/6/27 ..	19	—	—
11/3/27 ..	29	—	2	10/6/27 ..	16	—	2
18/3/27 ..	24	3	—	17/6/27 ..	22	1	1
25/3/27 ..	11	3	1	24/6/27 ..	25	—	3
1/4/27 ..	13	2	1	1/7/27 ..	—	—	1
8/4/27 ..	32	12	5	8/7/27 ..	19	—	2
15/4/27 ..	38	2	1	15/7/27 ..	No collection		
22/4/27 ..	33	—	2	22/7/27 ..	10	—	1

COTTON BREEDING WORK.

Observation Plots, Field 9.—Small bulks of the following varieties were grown:

D: A "Trice" strain imported in 1924 from the U.S.A.

N: A Columbia strain, called "Arizona," obtained from Mr. Salter, Northern Rhodesia.

G2: This was an increase plot from a selection made from a "Foster-Whitehall" cross obtained from the U.S.A. The original bulk G was grown in Field 8, 1925-26.

All these plots were planted on December 13.

TABLE V.

				Yield per Acre Seed Cotton (Total).	Order of Merit.	
					Earliness.	Resistance to Jassid.
D	..	..	..	334.5 lbs.	1	1
N	..	..	..	93.0 „	3	3
G2	..	..	..	112.5 „	2	2

Habit.—Strain D is a short, bushy type of plant. All through this season it promised very well, though strains N and G2 were early affected by Jassid and Aphis attack. The plot was unfortunately

affected somewhat by wash, and it is certain that but for this the yield would have been considerably greater. The lint length is unfortunately rather too low.

The plot of N suffered even more from the wash effect, but even making allowances for this it was disappointing both in appearance and yield. By the middle of February Jassid had begun to make itself felt, the whole plot being affected, though later some of the plants seemed to have weathered the attack. Several of the more productive of these were selected as parents for progeny rows to be sown next season. Two distinct types were present as regards earliness—a medium early type and a very late type, the latter being too late to be of much use under the Makwapala conditions.

The G2 strain was also heavily attacked by Jassid, and gave a disappointing yield. In the same field there were also grown some progeny rows, which were selections from progeny rows of G, which last season showed some resistance to Jassid. These were also disappointingly susceptible.

TABLE VI.
SELECTIONS MADE FROM STRAIN N.

<i>Serial Number.</i>	<i>Lint Length.</i> (<i>Mm.</i>).	<i>Ginning</i> (<i>per Cent.</i>).	<i>Weight (100</i> <i>Seeds) (Grms.)</i> .	<i>Lint Index.</i>
N-4	33.7	32.2	10.55	5.2
N-7	28.0	35.2	10.90	5.9
N-8	32.3	27.1	13.40	5.0
N-9	30.4	31.7	13.65	6.4
N-10	30.6	34.3	11.65	6.1
N-12	29.2	32.8	11.65	5.7
N-13	32.5	29.6	11.75	5.0
N-14	27.2	31.4	10.50	4.8
N-16	32.1	32.3	9.50	4.5

The lint length of these selections is excellent, and it is hoped to obtain from them a Jassid-resistant strain.

The D strain has a very high ginning percentage, and its productivity may prove valuable if a strain with a greater lint length can be isolated from it. The lint length of the bulk was 23.4 mm. (*N.B.*—All lint lengths as given in this report are mean maximum halo lengths.) Three selections of D, made 1925-26, have been grown as progeny rows, and will be discussed later in this report.

The G strain of Foster-Whitehall was a failure, and in view of its behaviour in this and past seasons it will be omitted from the future selection work at Makwapala. Its lint length, 29.8 mm., is good, and

it is satisfactory to note that it is proving a useful cropper this season at Port Herald.

In choosing the strain N selections, the late maturing types were avoided.

Breeding Plots.—Up to the present the selection work has been done from a few varieties which had succeeded in giving a crop of sorts in the very bad season of 1924-25. In that year many strains failed to crop altogether, and were so discarded automatically. It is significant that only one of the Nyasaland Upland selections survived, and even this did very badly in the following year 1925-26. This season it has been planted at Port Herald.

In the season 1924-25 a number of single-plant selections were made from the "Over the Top," strain B, and further selections from these sub-strains are still being carried on. In addition to these a few selections were made in 1924-25 from the original importation of "Over the Top" strain A. A small plot of "Trice," strain D, imported in 1924-25 from the U.S.A., was grown in the season 1925-26, which proved itself very productive and early. From it three single-plant selections have been grown. All these strains are short staples up to about $1\frac{1}{8}$ inches staple (Liverpool lengths).

Two importations of longer staples have survived, both originating from a Foster-Whitehall cross. These strains, G and H, differ mainly in habit—H being tall and open, rather like Nyasaland Upland, G being short and compact.

A large number of progeny rows of the above strains were grown, and in Table VII. are given the characteristics of the selections made in 1925-26, and grown this year in the breeding blocks as progeny rows. Thus in the past season there were thirty-seven single-plant selections grown, all second-year re-selections, except the progeny rows of strain D and the rows numbered 26 G—which were in their first year. One row of each was sown, the row being 200 feet long, giving a possible 100 plants at the 4 by 2 feet spacing in use. The stands obtained were very variable, and in some cases distinctly on the short side. This was mainly due to infertile seed, but partly the result of wash effects.

Selfing.—The method described in the 1925-26 Report was used, and found to be very satisfactory, except that a slightly larger rubber ring was found advantageous in order to facilitate removal of the gauze squares.

As a method of ensuring a supply of selfed seed under bollworm infestation conditions, this has much to recommend it. The ordinary tying method was, however, also tried and found satisfactory in the

absence of bollworm. At the Port Herald Station the tying method alone was used.

TABLE VII.

SEED AND LINT CHARACTERISTICS PROGENY ROW PARENTS SOWN IN
SEASON 1926-27.

<i>Plant Serial Number.</i>	<i>Lint Length (Mm.).</i>	<i>Ginning (per Cent.).</i>	<i>Weight of 100 Seeds (Grms.).</i>	<i>Lint Index.</i>
A-2-27 ..	26.2	30.8	11.15	4.9
A-2-49 ..	25.8	31.6	9.85	4.5
B-8-2 ..	24.8	32.5	9.92	4.8
B-8-10 ..	24.7	32.3	9.40	4.5
B-30-1 ..	25.3	31.9	10.12	4.7
B-30-6 ..	24.3	34.3	9.77	4.0
B-30-13 ..	24.5	34.4	8.52	4.5
B-42-1 ..	26.3	33.5	8.80	4.4
B-42-4 ..	24.7	33.3	8.62	4.3
B-42-11 ..	25.0	29.7	9.92	4.2
B-46-2 ..	24.8	34.3	9.72	5.1
B-46-22 ..	25.0	31.1	10.60	4.8
B-46-49 ..	24.5	30.1	11.42	4.9
B-46-55 ..	25.3	29.4	11.30	4.7
B-48-1 ..	24.7	31.9	11.65	5.5
B-48-6 ..	27.3	35.4	11.05	6.1
B-48-9 ..	26.0	33.6	11.90	6.2
B-48-17 ..	24.8	31.0	10.90	4.9
D-9 ..	23.5	36.7	8.89	5.2
D-21 ..	24.3	36.3	9.30	5.3
D-28 ..	24.8	38.9	7.80	5.0
26G-6 ..	29.5	31.9	11.25	5.3
26G-21 ..	30.0	33.3	10.82	5.4
26G-23 ..	30.2	32.7	9.52	4.6
26G-31 ..	28.2	35.7	10.75	6.0
26G-41 ..	30.5	33.0	9.95	4.9
G-1-5 ..	29.0	33.3	10.60	5.3
G-2-6 ..	27.8	33.2	9.54	4.7
G-2-16 ..	27.7	32.5	9.02	4.3
G-3-8 ..	27.2	34.4	10.08	5.3
G-6-3 ..	28.3	30.9	10.70	4.8
G-6-25 ..	28.5	31.6	10.22	4.7
H-1-5 ..	27.0	32.5	11.25	5.5
H-1-7 ..	26.6	33.9	9.53	4.9
H-2-3 ..	25.5	38.8	10.25	6.6
H-3-4 ..	29.2	32.4	10.00	4.8
H-3-9 ..	26.2	33.5	8.92	4.5

Notes on Selections.—Though the season on the whole was favourable to cotton, the incidence of Jassid was severe enough to test the selections severely as to their resistance. Early in the year Jassid was noted on the G selections, and the characteristic curling and leaf reddening was soon evident. By the end of February practically all flowers were being shed. Selfing was continued with a

few plants which showed some degree of resistance, but by the middle of April there was nothing to choose between any of the rows, the whole of the selections being leafless. This cotton in the previous season, one of high rainfall, had shown promise of yielding a resistant strain or strains, so that this season's results are a great disappointment. It is not intended to continue further with this strain at Makwapala, but to seek a long stapled strain in the N strain or elsewhere.

The Foster-Whitehall, strain H, has a slightly lower lint length than its sister G, and is of a different plant type of much more vigorous habit. Jassid attack was also observed on this strain, but with the exception of a few plants the H selections stood up well and carried a good crop. One selection is possibly worth bulking, and further selection will be done for the most resistant types.

The "Trice," strain D: Three selections were grown, and all did well in the field, the Jassid effect on them being very slight. The feature of this strain is its earliness and prolific cropping, but in staple it proved very short, the best row being only 22.3 mm., which is not as good as the mean length of the bulk.

Of the "Over the Top," strain B, a considerable number of second-year selections were grown, and all proved vigorous and productive. Very little Jassid damage was found, and selections, to carry on to next season, have been made, chiefly on lint and seed characteristics. The habit of growth of some of the rows was not too good, and this has been one line of selection. As regards staple, the selections show considerable improvement on the bulk strain B, and during the next season increase plots will be grown of the more even rows. It should be possible to replace the present mixed bulk with one or more pure lines within the next three years.

Strain A has a much better branching habit than its sister strain B. Two selections were grown, and both showed a very high degree of resistance to Jassid. They were both rather leafy, however, and this in a year of high rainfall might be a disadvantage. In staple they were slightly better than the B selections.

Every plant of all the selections, with the exception of the G strains, was examined in the laboratory for lint and seed characteristics, the mean maximum halo length of ten seeds taken at random from each plant being measured. Altogether about 1,000 plants were examined, and to save time the method of combing one side of the halo only was tried; this proved quite satisfactory, and was much quicker than combing out the whole halo. The boll weight was found for each row, the weight being that of the mean of at least fifty bolls.

Table VIII. gives the characteristics of the rows selected for carrying on to next season as observation and increase plots.

Table IX. gives the characteristics of some of the single-plant selections which are to be carried on to next year as progeny rows.

TABLE VIII.

Row.	Lint Length (Mm.).	Ginning (per Cent.).	Weight of 100 Seeds (Grms.).	Lint Index.	Boll Weight (Grms.).
A2-49 ..	25.36	33.2	11.00	5.4	5.10
B-30-1 ..	24.5	32.2	9.8	4.7	5.91
B-42-1 ..	24.5	35.7	9.4	5.2	5.07
B-42-4 ..	24.2	32.7	8.6	4.3	4.92
B-46-2 ..	23.8	30.8	11.2	5.0	5.36
B-46-22 ..	23.9	32.7	8.7	4.2	5.73
B-46-49 ..	24.0	33.1	10.4	5.2	5.98
H-1-5 ..	26.3	35.1	11.89	6.5	5.64
H-2-3 ..	27.2	35.4	12.18	6.7	5.55

TABLE IX.

Selection.	Lint Length (Mm.).	Ginning (per Cent.).	Seed Weight (Grms.).	Lint Index.	Locus Number.	Boll Weight (Grms.).
A2-49-1 ..	24.9	32.7	10.85	6.3	4.0	5.10
A2-49-2 ..	26.5	34.7	10.3	5.5	4.4	5.10
A2-49-3 ..	25.5	32.7	12.6	6.1	4.0	5.10
B-8-2-1 ..	26.0	31.8	10.4	4.9	4.4	4.48
B-8-2-2 ..	25.9	29.1	13.1	5.4	5.0	4.48
B-8-2-3 ..	24.2	34.5	11.0	5.0	4.0	4.48
B-42-11-1 ..	26.0	32.0	11.5	5.4	5.0	5.53
B-42-11-2 ..	26.0	33.2	11.1	5.5	4.5	5.53
B-42-11-3 ..	26.0	33.3	11.6	5.8	4.0	5.53
H-1-5-1 ..	26.0	34.6	12.7	6.8	4.5	5.64
H-1-5-2 ..	26.3	34.6	12.1	6.4	4.3	5.64
H-1-5-3 ..	26.8	35.3	13.6	7.4	4.1	5.64
H-1-5-4 ..	29.2	32.7	13.1	6.4	4.5	5.64
H-1-7-1 ..	27.7	34.1	9.9	5.1	—	5.18
H-1-7-2 ..	26.5	35.8	9.8	5.4	4.3	5.18
H-3-4-1 ..	27.5	31.7	12.3	5.7	4.3	5.44
H-3-4-2 ..	30.2	32.3	11.5	5.3	4.3	5.44
H-3-4-3 ..	30.4	30.8	10.1	4.5	4.5	5.44
H-3-4-4 ..	28.2	29.4	12.3	5.1	5.0	5.44
H-3-9-1 ..	26.7	33.2	13.0	6.5	4.6	4.83
H-3-9-2 ..	26.4	33.1	11.1	5.6	5.0	4.83
H-3-9-3 ..	28.9	31.8	10.4	4.9	5.0	4.83
H-3-9-4 ..	29.2	31.2	11.0	5.0	4.8	4.83

Hybridization.—Several crosses were made during the past season, and to save time the F1 generation is being grown out of season at

Port Herald. By so doing it is hoped to save a year, and obtain an F2 in time for the 1927-28 season.

1. A1 $\times$ G736.—A1 is a vigorous productive plant of "Over the Top" with marked Jassid resistance. G736 is a Foster-Whitehall with a very good staple length.

2. B12 $\times$ G736.—Another "Over the Top" cross with Foster-Whitehall.

3. D675 $\times$ H1266.—The short-stapled highly productive "Trice" strain crossed with a long linted Foster-Whitehall.

4. B575 $\times$ G946.—Parents resemble the second cross.

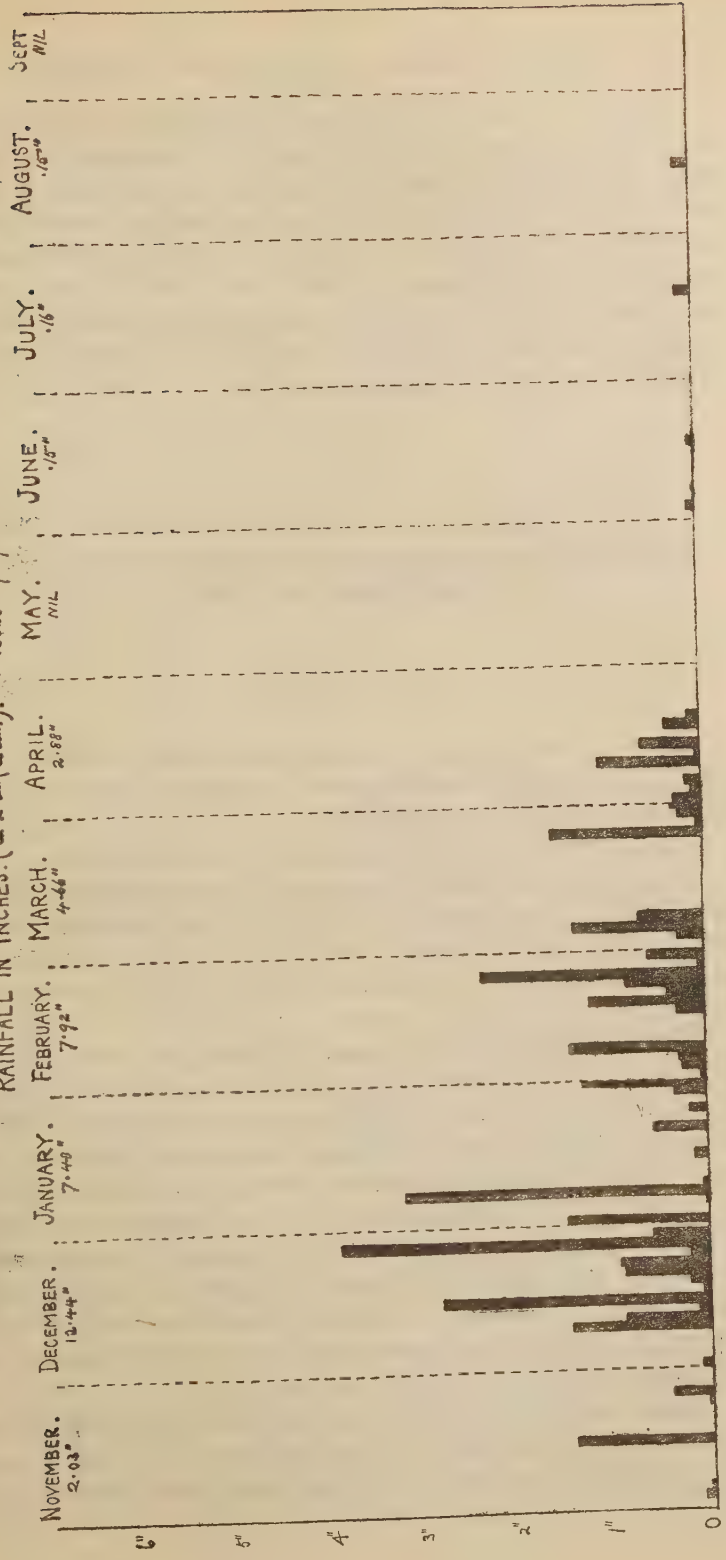
Natural Crossing.—It was early observed that the number of bees visiting the plants in the breeding plot was surprisingly small. Further observation discovered large numbers of bees on the flowers of the two plots of sunflowers (*Helianthus annuus*) which were grown near the breeding block. On the cessation of flowering of the sunflower plots, about the middle of March, the numbers of bees seen on the cotton flower increased enormously. It is considered that this observation may be found of use in reducing the amount of natural crossing in the unselfed increase blocks. With this in view strips between the blocks will be planted with sunflowers at various times to allow of a succession of flowerings to cover the majority of the season.

Insect Pests.—The insect pests of major importance during the season have been Bollworm (*Diparopsis castanea*), Stainer (*Dysdercus* sp.), and Jassid.

The bollworm attack was decidedly less severe than in the previous season, but it is difficult to say at this stage exactly what the reason for the variation in the intensity of the attack may be. It is possible that the moth-catching of the previous season may have had some effect, though there is no evidence that this is so, and also that the system of rotational cropping has some effect in limiting the attack, but it is considered that the lesser attack is due in greatest measure to the season. Last year cotton was grown under conditions of very high rainfall, and the plants developed a dense leafy habit, while this season the plants were more open and the dry season allowed of more adequate inter-cultivation. It was noticed this season that where conditions had favoured heavier growth the infestations were heavier. A few rows of cotton have been left for ratooning in November this year, in order that the early hatchings of pests may be trapped on these and destroyed.

Stainer (Dysdercus sp.).—The attacks of this pest were most severe on the later pickings, when trapping with cotton seed was useless.

MAKWAPALA EXPERIMENT STATION, NYASALAND.
 Total 37.87"
 RAINFALL IN INCHES. (in 2-day totals).



Jassid.—The season was favourable to this pest, and the strains were tested severely. On the whole the "Over the Top" strains came through the test very well, but it was very evident that the severity of the attack depends, to a great extent, on the condition of the plant. The worse the soil conditions, the more evident the effect of the pest. This showed up clearly when Field 10 was compared with Field 3. The former was protected against wash by the ridge terraces, while the latter washed quite badly in places, and the effect on the cotton was most marked.

PORT HERALD COTTON STATION, REPORT FOR THE SEASON 1926-27

BY

E. LAWRENCE.

Season.—Despite a rather unusual distribution of rainfall, with a total some 10 inches below normal, this season has not been unfavourable to cotton at Port Herald.

The long dry spell during August and September was very welcome on the station, and picking was carried out under ideal conditions. At the same time, however, this dry spell has delayed the native cotton which was late-planted, and it is extremely doubtful whether some of this will bear a crop in time for harvesting before the date of uprooting.

The first rains fell at the end of November, and were followed by intermittent light showers until the end of December, when the heavy rains broke. These lasted about a fortnight, and were followed by several unseasonable spells of bright, hot weather, which were, however, broken by numerous showers which kept things going. The January rainfall was well below normal, and it was not until the first week in March that a good fall came to make up for the previous shortage. This fall coincided with the high wind which Makwapala experienced, but though Port Herald shared this weather with the up-country station no damage was done, though a little of the Macheweri millet, then in head, was laid.

At the beginning of 1927 the station was equipped with thermometers (maximum, minimum, wet and dry bulb) and a thermohygraph, and continuous meteorological records have been kept

since February. In addition weekly records have been kept since April of soil temperatures at depths of 1, 2, and 3 feet.

General.—The Station, the extension to which was completed during the latter part of 1926, was laid out in twelve fields of $2\frac{1}{2}$ acres each, arranged six fields either side of a rectangular building block.

A rotational cropping scheme was devised for the station closely on the lines of that adopted at Makwapala, except for the omission of tobacco. The cottons sown were all from Makwapala crops of the previous season, with the exceptions of two new introductions—Arizona from Mr. Salter, Northern Rhodesia, and Z1. BTN/24-/25, from Mr. Parnell, Barberton, South Africa. A contour survey of the station was made and showed a very even and slight fall from north-west to south-east. A simple drainage scheme was at once carried out, and found to be sufficient to deal with the heaviest falls of the season. The soil is open and absorbent, and this in itself is a great check to soil erosion. After the troubles of Makwapala in this connection it is a great blessing not to be troubled by wash.

The building, in the form of a hollow square, comprising stores, stalls for three pairs of cattle, and a farm office, was completed and roofed with corrugated iron, and the sinking of the well is nearly finished. In regard to the latter, an attempt was made to sink the well to water with the idea of bricking in afterwards. Unfortunately a stratum of fine sand caused the shaft to collapse, and it has been found necessary to sink a brick shaft which is supported on a concrete ring.

Permanent Native labour lines in the form of brick-built rondavels are in the course of erection on the north side of the station, four having been built on the buildings block for the head boys. A meteorological hut and a carpenter's shop have also been built, and a brick retaining wall for a compost heap is at present under construction.

Sisal has been planted as a boundary hedge round the entire clearing, and at the commencement of the 1927-28 rains Napier fodder was planted as borders to all the fields, as has been done at Makwapala.

During August two more bullocks were obtained from the Government herd on its dispersal, and are now being broken in to work. There are now three pairs of working bullocks on the station.

Various pests, animal and insect, have made their presence felt in different ways during this season. Towards the end of April por-

cupines invaded the groundnut field nightly, and did considerable damage, until the watchman succeeded in spearing three of them; this, coupled with endeavours to dig the survivors out of their burrows, had the effect of driving the latter away. A hyena ate the rain gauge top one night, and small buck did a little damage to the Macheweri. The most serious pest on the cotton, however, has been Stainer (*Dysdercus* sp.), which was without a doubt responsible for most of the stained cotton damage. With the increase in numbers of the stainer in July and August the cotton picked in August and September became progressively more stained.

The first appearance of the stainer was noted during the second week in April, and from that time, until the middle of September, it has never been difficult to find some, though the population appeared to vary in numbers considerably. This insect is certainly most active in dull wet weather, and in the early morning. During hot weather stainers were found in large numbers in any kind of shade, particularly under fallen leaves and other rubbish. They were very numerous indeed at the beginning of August, and were to be found in all stages of development. Eggs were found under heaps of dry trash, but never on the cotton plants.

Dysdercus has been found breeding on a Native malvaceous tree called Ngoza; this has not so far been identified. Young colonies have also been observed on a *Thespesia* near the station.

Oxycarenus sp. were not noticed until picking time, when they were found in very large numbers on the seed cotton.

Periodic catches of bollworms were made, and the collections analyzed by Mr. King, the Corporation's Entomologist. During May and June the American Bollworm appeared in small numbers, while the Spiny Bollworm (*Earias*) has been present in small numbers throughout the season. The Red Bollworm has, however, undoubtedly been the most important of the three this season. During April and May a very large number of plants were topped by this pest, particularly in the progeny rows. The damage done to the bolls, however, though considerable at first, was later completely overshadowed by the stainer attack.

The early planted cottons, January sowings in Field 7, were very badly attacked by a leaf-roller in April-May, and many of the plants almost completely defoliated. By August, however, the plants had recovered.

Generally speaking, the insect pests have done more damage to the quality than to the quantity of the cotton crop.

ROTATIONS.—The cropping scheme for the station was as follows:

		Field.	Field.	Field.
Rotation	I.	6. Cotton	3. Cereals	—
„	II.	4. Cotton	1. Fibres	2. Cereal-pulse
„	III.	7. Cotton	10. Oilseeds	8. Cereal-pulse
„	IV.	9. Cotton	11. Oilseeds	12. Cereal-pulse

Miscellaneous Block, Field 5: Miscellaneous crops and cotton-breeding plots.

ROTATION I.: COTTON, CEREALS.

Field 6: Cotton.—This field was sown with “Over the Top,” strain B. With all the cottons at Port Herald this season, with the exception of the time-of-planting experimental plots in Field 7, the sowing date was as near as possible to February 15, 1927. Field 6 was actually sown on February 10. Sowing was done at a spacing of 4 by 2 feet, twelve seeds per hole, and the crop thinned to two plants per hole on March 16. A certain amount of supplying was done, but too late to be of any use. The crop was flowering freely by April 15, and the stand on June 16 was 57 per cent. of the possible total. Planting conditions were good throughout, and poorly germinating seed is the only explanation of the short stand. Field 9, planted the following day, but with a different lot of seed, gave an 84 per cent. stand. Picking commenced on July 25, and continued until late in the year.

Field 3: Cereals.—This field was divided into four parts, as with Field 1 at Makwapala, and planted up with the same seed lots in the same way. Having previously been a Native Mapira garden the soil proved to be in poor heart, and the four cereals sown yielded poorly.

Macheweri (Pennisetum typhoideum).—The seed was drilled in 30-inch rows on December 24, and later thinned to 9-inch spacing in the rows. Growth was fair, and the crop was harvested on March 21. The heads were cut off in the field and stored, the straw being stacked on the buildings block for use as cattle litter. The yield obtained was 1,161 lbs. grain per acre. It may be noted that there was a considerable loss from the depredations of grain-eating birds.

Maize (Zea mays).—The variety Potchefstroom Pearl was sown on December 24 at a 4 by 2 feet spacing, four seeds per hole. A fair stand was obtained, the crop being thinned to two plants per hole on January 27. The crop was harvested on April 4, stooked in the field, and after drying out, the straw was stacked and the cobs stored. The yield was very low, only 1,104 lbs. grain per acre. Neither the soil on the station nor the climate is really suited to maize growing.

Native maize in the ordinary way is only grown as a cold-weather crop on the Dimba ground when the floods have receded.

Mapira (Sorghum vulgare).—Sumbwi was drilled on December 24, the same spacing being used as for the Macheweri. The crop grew badly, suffered greatly from rust, and was barely worth the trouble of harvesting. This was done on April 15, and only resulted in 248 lbs. grain per acre.

Maweri (Eleusine coracana).—The same variety was sown as at Makwapala, and the crop was treated in the same way. Ripening was rather uneven, and the crop was finally harvested on May 28. The yield of grain was 1,064 lbs. per acre.

A strip along the outside of the field was planted with the Native cowpea (*Vigna catjang*), which made quite a fair growth, and evidently has possibilities as a rotation pulse crop. It yielded at the rate of 896 lbs. grain per acre.

ROTATION II.: COTTON, FIBRE, CEREAL-PULSE.

Field 4: Cotton.—This field was used in part for a set of spacing experimental plots and a variety test, both on the lines of Field 2 at Makwapala, and in part for a small bulk of "Over the Top," strain B. The plot layout is described later in the report. The whole field was planted on February 16, the small bulk being treated like that of Field 6.

Field 1: Sunnhemp.—Sowing was done broadcast on December 21 at the rate of 50 lbs. per acre, and the seed bush-harrowed in. Germination and subsequent growth were rapid, and only a cursory hand-pulling of weeds was necessary. Soon after the pods formed, experimental rettings were commenced, and were continued until the crop was harvested for seed on May 16. The best and cleanest fibre was obtained from samples retted a fortnight to three weeks before the seed was ripe. Earlier rettings gave a very weak fibre, and the fibre resulting from later rettings was of a bad colour. A yield of 300 lbs. seed per acre was obtained, and from small trial areas the estimated yield of fibre was 500-600 lbs. per acre. Compared with the growth at Makwapala, that of the Sunnhemp at Port Herald was very short.

Field 2: Cereal-Pulse.—Half this field was sown with Macheweri, as for Field 3, and half with pigeon pea. The Macheweri was harvested on March 19, and gave a yield of 1,206 lbs. grain per acre.

Pigeon Pea (Cajanus indicus).—This half of the field was sown on December 20 with seed obtained locally of the variety *Mtundu wa Angulu*. The seed was drilled in 30-inch rows, and the plants thinned

to 9 inches apart in the row. Pigeon pea is treated locally as a perennial, and is usually left six to seven years without resowing. This year on the Station it gave indications that it will prove valuable as a close-spaced annual crop: as a cover it was as good as the Sunn-hemp. Harvesting is just commencing at the time of writing (November), and the yield promises to be a heavy one. As a soil-renovating crop, this appears to be of considerable merit. In addition, it is a favourite food of the Angulu, and is therefore welcome to the station labour, who are mainly of this tribe.

ROTATION III.: COTTON, OILSEEDS, CEREAL-PULSE.

Field 7: Cotton.—The north side of this field was sown with a small bulk of strain B, as for Field 6. The balance of the field was laid out in a series of time-of-planting experiments which are described later in this report. The small bulk and the control plots of the experiments were planted on February 14 at a spacing 4 by 2 feet. The former was thinned to two plants per hole, the latter to one plant per hole.

Field 10: Groundnuts.—The oilseed in this rotation was groundnuts. Half the field was sown with Spanish bunch, half with Chimbuwila. The seed was dibbled in at a 10 by 10-inch spacing during the last week of December and the first week of January. The Spanish bunch was harvested during the last week of May, and the Chimbuwila in the middle of June. The Spanish bunch yielded 1,316 lbs. unshelled nuts per acre, the Chimbuwila 765 lbs. per acre. This is a much greater discrepancy than has been shown at Makwapala.

Field 8.—This was sown with Macheweri and pigeon pea in exactly the same way as Field 2. The Macheweri yielded 1,362 lbs. grain per acre.

ROTATION IV.: COTTON, OILSEED, CEREAL-PULSE.

Field 9: Cotton.—This field was planted with Foster-Whitehall strain G, the strain which had failed badly at Makwapala the previous year owing to Jassid damage. The crop was sown on February 11, 12 seeds per hole, at a spacing 4 by 2 feet, as for Field 6. Germination was good, and on March 15 the plants were thinned to two per hole. The field was supplied on March 7, but the supplies came to nothing. The crop was in full flower on April 20, and picking was commenced on July 20. An excellent stand of 84 per cent. of the total possible was obtained. Jassid nymphs and adults were numerous during March, April, and May, but beyond a small amount of leaf reddening,

of which they may or may not have been the cause, the plants were unaffected. The only explanation so far put forward is that in addition to "dodging" the worst of the bollworm the crop also dodged Jassid with the aid of the late planting.

Unfortunately the crop did not dodge the stainer attack which developed in July, and the proportion of clean cotton was consequently lowered considerably. The yield from this field of $2\frac{1}{2}$ acres was 1,999 lbs. of seed cotton. Of this the B.C.G.A. reported 1,574 lbs. as being clean white cotton, with a ginning percentage 84.8. Hence the yield per acre of clean white cotton was 216 lbs. of lint of staple length $1\frac{1}{8}$ inches full to $1\frac{3}{8}$ inches. If it continues to do well under Port Herald conditions, a very valuable strain for the Lower Shire has been found. It only remains to be ascertained if the spinning quality of the lint is as good as the length would indicate.

Field 11: Sesamum.—The oilseed in this rotation was sesamum, a very commonly grown Native crop in the Port Herald district.

The seed was broadcasted at the rate of 5 lbs. per acre on February 5, and a fair stand obtained. The lack of rain in February turned the crop a yellowish colour, but the fall in March mended matters, and the crop ultimately made quite good growth. Harvesting commenced on May 3, and a yield of 430 lbs. grain per acre was obtained. It was found a difficult crop to handle, and much seed was lost through shattering. An improved method of harvesting the crop is now under consideration, which, if successful, may greatly help matters.

Field 12.—This was planted with Macheweri and pigeon pea in exactly the same way as were Fields 2 and 8. The Macheweri yield was, however, rather better on this field, amounting to 1,743 lbs. grain per acre.

Field 5: Miscellaneous Crops and Cotton-Breeding Plot.—The cotton-breeding plot will be referred to later.

The miscellaneous crops consisted of a number of observation plots of various potential rotation crops. They were as follows:

Mapira.—Eight varieties of Mapira were grown, and all did well. Especial mention may be made of a variety, Lusembeleka, which, in addition to giving a very fair yield of grain, also had a sugar-bearing stem, which met with considerable favour both with the Native labour and with the cattle.

Macheweri.—A variety known as Nachacha, having awned glumes, yielded well as compared with the ordinary Macheweri in Fields 2, 8, and 12. The difference was in part due to the protection given to the grain by the awned glumes against the small grain-eating

birds. On the other hand, it compared badly with Macheweri in that it did not ripen until over one month later. This is of importance to the Natives, since they depend on the Macheweri as their earliest grain crop.

Pulses: Tepary Bean (*Phaseolus acutifolius*) did well, but would have been better in closer spacing; 15 by 9 inches is suggested as suitable. Green Gram (*Phaseolus mungo*) and Bush Lima Bean (*P. lunatus*) also did well, while the Kenya Pigeon Pea did not appear to be so good as the local variety.

Dolichos Lablab, after promising to give a very good crop, was practically wiped out by the attack of leaf-eating beetles known to the Natives as Magombera, but not specifically identified.

COTTON EXPERIMENTAL WORK.

As mentioned under "Rotations," Fields 4 and 7 were in part reserved for a set of field experiments dealing with the following points: spacing tests, a variety trial, and a time-of-planting experiment. The spacing test and variety trial followed on exactly the same lines as the Makwapala experiments, and the same type of half-drill-strip layout was used. The ridge and flat experiment was, however, omitted. The control used was the same as at Makwapala—viz., strain B, sown at a spacing of 4 by 2 feet, one plant per hole. The various spacings tried were as follows:

						<i>Plants per Acre.</i>
4 by 2 feet	..	..	..	..	Two plants per hole	10,890
4 " 1½ "	..	..	..	..	One plant per hole	7,260
4 " 1½ "	..	..	..	..	Two plants per hole	14,520
4 " 1 "	..	..	..	..	One plant per hole	10,890
4 feet by 6 inches	..	..	..	..	One plant per hole	21,780

The experiments showed in all cases an increase of yield over the standard spacing used for comparison. The significance of this, however, is somewhat inconclusive, but it is interesting to note that the densest spacing, that of 4 feet by 6 inches, approximating to that most favoured by native cotton growers, showed the highest percentage increase in yield over the standard; while the second highest percentage increase was shown by the 4 by 2 feet (two plants per hole) spacing, which is the ordinary spacing used for bulk sowings at both stations. The experiments will be repeated this coming season.

The variety trial was precisely similar to that at Makwapala, and a small staff of Native observers was recruited for the continuous records, and assisted by the presence of an experienced boy sent down from Makwapala. The test showed a significant difference

in favour of the Nyasaland Upland Lisungwe strain. This result is in accordance with the general observations made on the "Over the Top," strain B, in all the bulk plots of it which were sown in the Lower Shire area. The non-success on the Lower Shire of a variety evolved to suit up-country conditions may be noted.

The time of planting experiment was peculiar to Port Herald, since, with the short season at Makwapala, the time to plant there is merely a matter of when the first sowing rains fall.

As reported last season, it was observed that the time of planting made a great deal of difference to the growth of cotton in relation to the incidence of the insect pests, and it was felt that so important a subject should be investigated at once.

It was decided to adopt the same half-drill-strip method of plot layout for the time of planting experiment as was used for the spacing and variety trials. Strain B was used throughout, sown at 4 by 2 feet spacing, one plant per hole. The standard control plots were all sown on February 15, and the time of planting plots were sown as follows—one set of six replicates at each date as follows:

January 1,	March 15,
January 15,	April 1,
February 1,	April 15.

March 1 was unfortunately missed, owing to the station having run out of seed, and the seed which was on the way from Makwapala being held up on the railway after the service was reorganized following the flood damage.

The experiments were somewhat marred by the poor stands obtained on the standard plots sown on February 15. The results were therefore worked out in two ways—per plot and per 100 plants. Allowing for the good stand of the January 1 sowings as compared with its standards, there appears to have been no advantage in planting cotton at Port Herald before February 15 this last season. In view of the fact that the experiments showed that there was a significant disadvantage in planting as late as March 15, it is a great pity that non-arrival of seed made it impossible to plant any plots on March 1. It is of interest to note that the January 1 and January 15 plantings suffered severely from leaf-eating caterpillars.

The experiment will be repeated this coming season, using dates ranging from January 1 to April 1, so far as possible at fortnightly intervals. The actual dates will, of course, depend on the incidence of the rains.

Breeding Work.—As mentioned under Field 5, at the end of the description of the rotations, part of this field was used as the cotton-breeding plot. Here the cotton-breeding work, as in progress at Makwapala, has been duplicated, and from the work that is being done it is expected that new strains of cotton will ensue which will be peculiarly suited to the Lower Shire conditions. Results so far certainly indicate that this will be so, since we already have a variety which, though a failure in the higher country, is giving good returns this season at Port Herald.

Selfing.—In the absence of serious loss from bollworm damage, it was decided to use the tying method of ensuring self-fertilization of the flowers of cotton in the breeding block. Wool was at first used, and later replaced by soft twine, which was found to answer just as well, and had the advantage of being much cheaper. All successfully selfed flowers were marked by tying a small piece of coloured material to the petiole. No harm was done to the flowers so far as could be observed, but the handling of the plants certainly encouraged shedding. It was noticeable that throughout the time of flowering the progeny row plants were later than the neighbouring bulks and remained green longer.

APPENDIX I

ANALYSIS OF BOLLWORM POPULATION, WEEKLY COLLECTIONS.

Red Bollworm (*Diparopsis castanea*)=R.B.W.American Bollworm (*Chloridea obsoleta*)=A.B.W.Spiny Bollworm (*Earias* spp.)=S.B.W.

Date.	R.B.W.	A.B.W.	S.B.W.	Date.	R.B.W.	A.B.W.	S.B.W.
7/5/27 ..	99	12	12	13/8/27 ..	23	—	—
14/5/27 ..	63	14	3	20/8/27 ..	34	—	—
21/5/27 ..	16	18	3	27/8/27 ..	71	—	4
28/5/27 ..	34	6	1	3/9/27 ..	44	—	3
4/6/27 ..	71	2	6	10/9/27 ..	58	—	1
11/6/27 ..	64	—	10	17/9/27 ..	45	—	2
18/6/27 ..	74	—	12	24/9/27 ..	54	—	5
25/6/27 ..	75	3	9	1/10/27 ..	29	—	5
2/7/27 ..	53	1	20	8/10/27 ..	29	—	7
9/7/27 ..	33	—	20	15/10/27	28	—	—
16/7/27 ..	18	—	1	22/10/27	45	—	4
23/7/27 ..	17	—	6	29/10/27	44	—	12
30/7/27 ..	34	—	5	5/11/27 ..	40	—	4
6/8/27 ..	21	—	6	12/11/27	36	—	2

The above figures give the relative importance of the pests throughout the season, but are not in any way a guide to the numbers of bollworm present in the cottons at any one time. After June a very much larger area of ground had to be searched to afford a sufficient number to examine than sufficed prior to this date.

The American Bollworm is most definitely a pest at Port Herald, occurring early in the season.

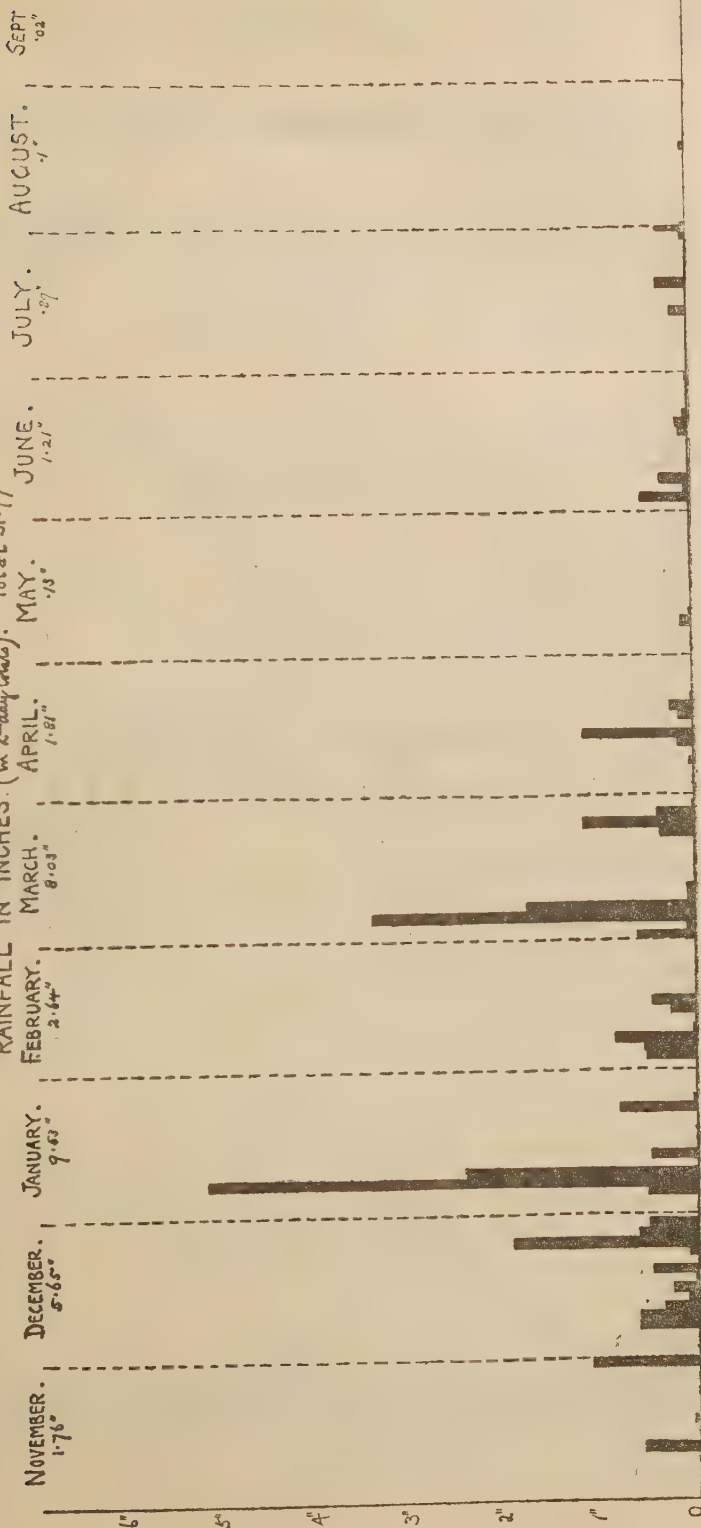
APPENDIX II

CATCHINGS OF RED BOLLWORM MOTHS.

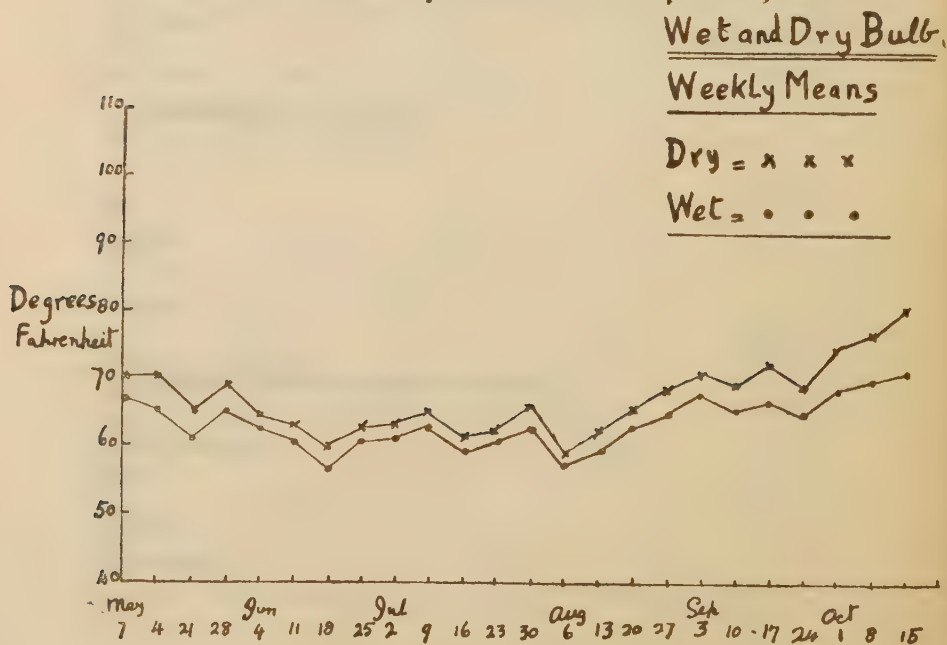
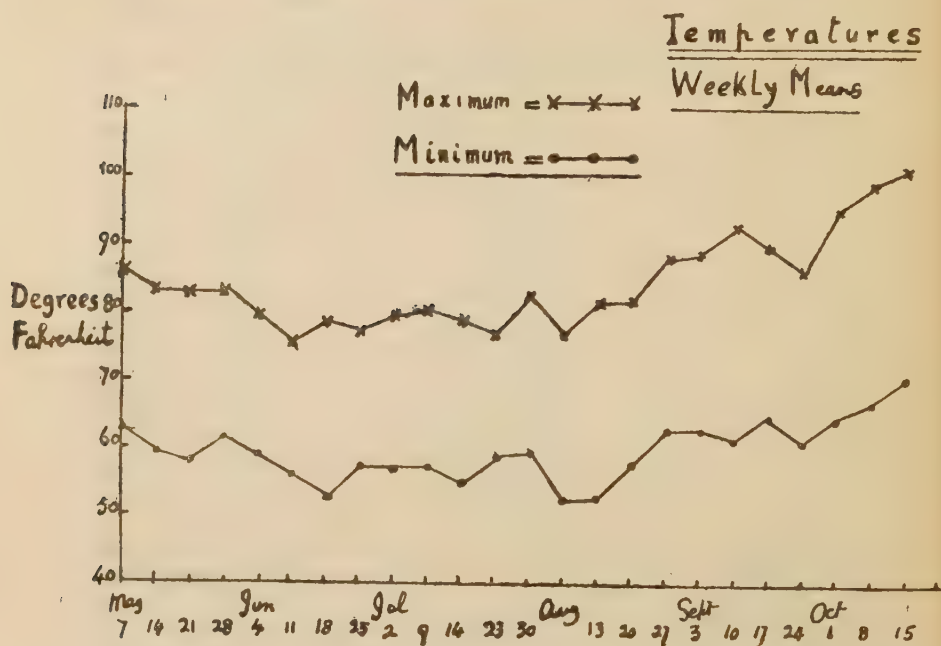
Month.	Males,	Females.	Totals (Including Moths of Sex Unidentified).
February	70	88	303
March	270	339	843
April	—	2	2
May	—	1	1
September	1	2	3
October	2	1	3

PORT HERALD EXPERIMENT STATION, NYASALAND. SEASON 1926-27.

RAINFALL IN INCHES. (in 2-day tides). Total 31.77"



Port Herald.—Continuous Record Diagrams.

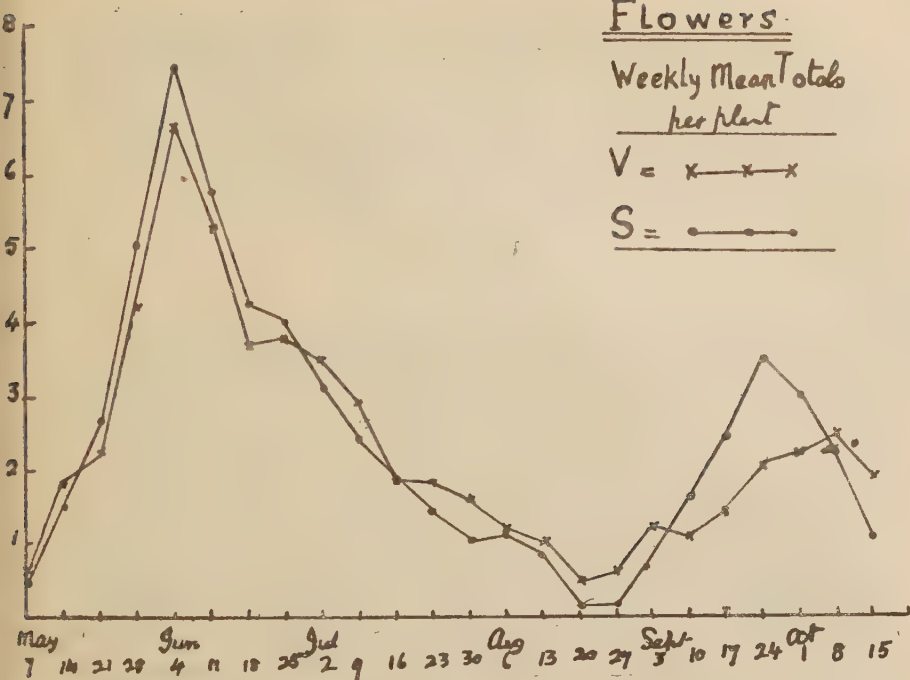


Flowers

Weekly Mean Totals
per plant

V = x—x—x

S = •—•—•

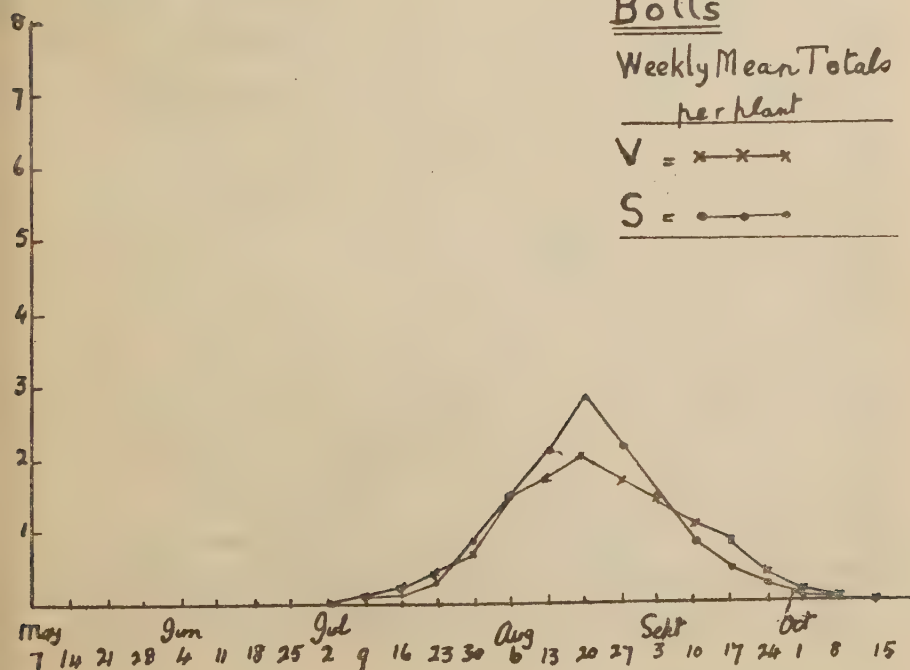


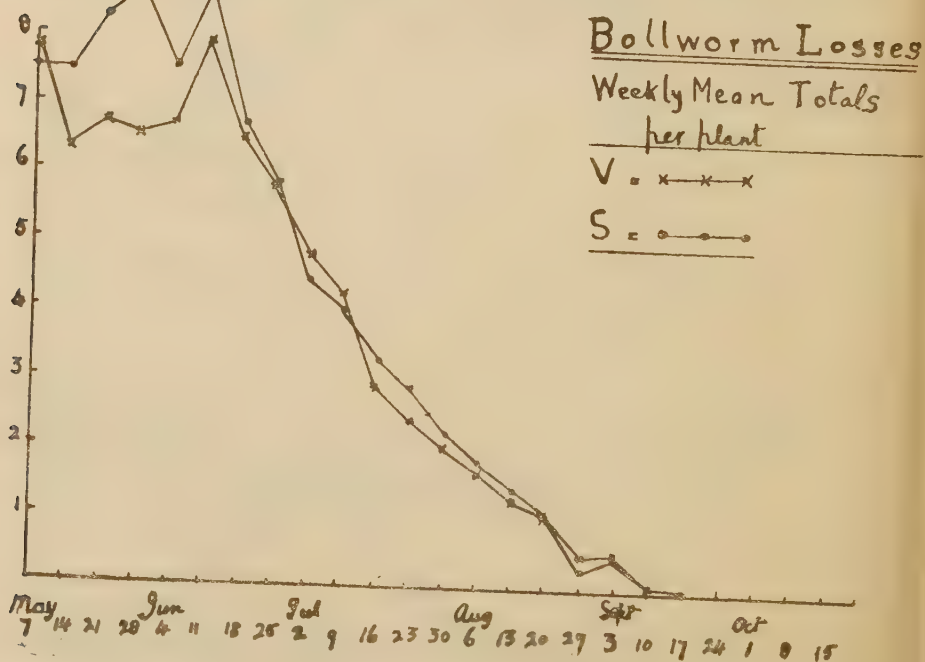
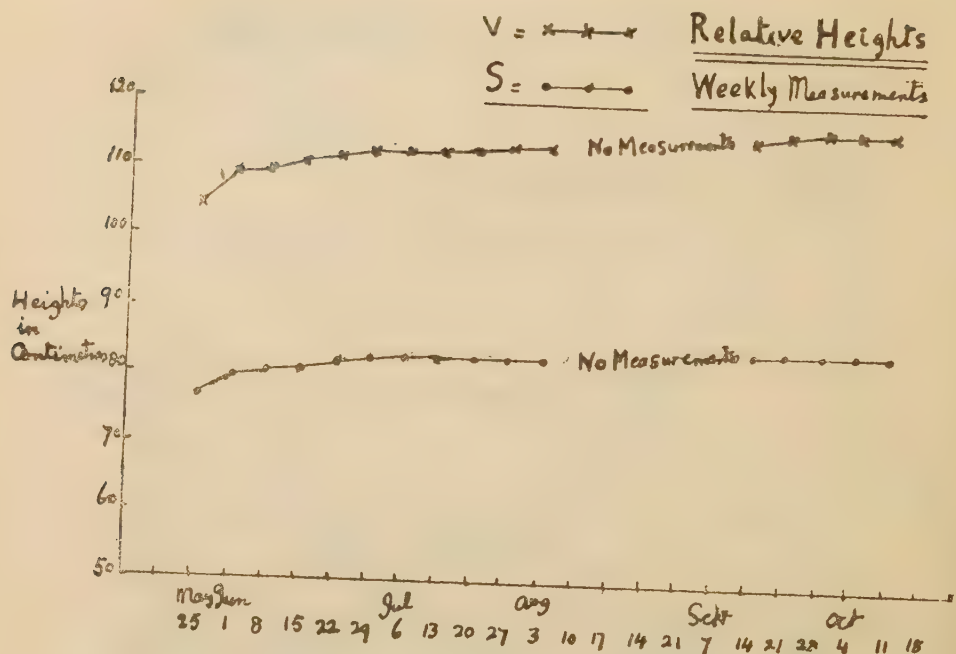
Bolls

Weekly Mean Totals
per plant

V = x—x—x

S = •—•—•





REPORT ON ENTOMOLOGICAL WORK ON COTTON, SEASON 1926-1927

BY

C. B. R. KING.

It was decided this season to continue the experiment of catching the moths of the red bollworm, and to attempt to devise some means of trapping stainers.

The Red Bollworm.—Five acres of cotton were planted this year in a field which had been under maize in 1926 and under cotton in 1925. There had, however, been two acres of cotton in one corner last year about 150 yards from the present block, which, in turn, was some 400 yards from last year's ten-acre block of cotton. It was therefore hoped that all moths attacking the crop would fly in from the outside, and that none would emerge in the midst of the crop. This proved to be very substantially, if not entirely, the case.

Hand-picking of moths was begun as soon as the squares showed on the plants towards the end of January, and this was continued until the end of February, when the cotton became too bushy to find them. At this time a Meduse light trap arrived, kindly supplied for trial by Messrs. Cooper, Pegler and Co. This takes the form of an open acetylene flame above a shallow basin in which water and paraffin are placed. The trap proved successful in that it caught nearly all the moths that flew into the field from outside, for the field remained comparatively free from fresh eggs, except in places remote from the light, where a very small second generation made its appearance. In my previous report it was stated that "acetylene light traps failed to capture a single *Diparopsis*." These conflicting results are apparently due to the form of the lure, which in the instance just quoted took the form of a beam projected from a cycle lamp.

The most important of the conclusions to be drawn from the results of these experiments is that immigration of moths only took place in a favourable wind. In 1926 there had been cotton on the west, north, and east sides of this year's block, and whenever there was an evening breeze towards any of these directions an influx of moths was observed, and the west, north, and east edges of the block

were considerably more attacked than the remainder of the field. When the wind blew from the north, or there was no wind at all (a combination which occurred for a few days after March 5), no moths were caught and no fresh eggs were found. On March 22 the wind changed to the south, where it remained for a fortnight, and fifty moths were caught in this period. The moths thus captured included both sexes, and all females examined contained mature eggs. The numbers caught by the trap were as follows:

1927.	<i>Males.</i>	<i>Females.</i>	<i>Remarks.</i>
March 2 to March 5	—	10	March 18, Full Moon.
„ 6 to „ 21.	—	—	
March 22 to April 7	38	22	April 17, Full Moon.
April 8 to „ 18	—	—	
„ 19 to „ 29	15	—	

No moths were caught after April 29. The numbers of females fell right away in April, but males were still in evidence, confirming the fact observed in the previous season that the males greatly preponderated towards the end of the rains.

The trap has a non-working period for practically all insects each month during the second week of the moon, though it is possible that this period might be reduced if stronger lights were used. A trap having two jets instead of one will be tried next season.

The total catch shows that the density of moths caught was 30.5 per acre, comparing with 160 per acre from the cotton of the previous season. The yield of cotton has improved from 92 lbs. of lint per acre last season to 180 lbs. of lint per acre from the first crop only; the second crop has not yet been picked (November 2), but will probably yield another 50 lbs. or so of lint per acre. The yield is about three times the average on this estate for the past six years. The cotton grown was “Over-the-Top,” which was kindly supplied by Mr. Ducker, who tells me that the cropping possibilities of this variety are not more than 10 per cent. greater than those of the local Upland. Last year’s yield was low owing to an unfavourable growing season, and it was also the first year in which the system of catching moths as a method of control was tried.

Other Bollworms.—Other bollworms were only found in small numbers. The light did not appear to exert much influence on *Chloridea* (*Heliothis*) and *Earias* moths, as only one of the former and two of the latter were caught.

Stainers.—Cotton seed traps were put down early in February. A V-shaped pit, the width of a hoe and 12 inches deep, was dug at intervals of 50 yards round the cotton field. In these a handful of cotton seed was placed. Stainers gradually became numerous, and when found in the trap, the earth was shovelled back in the pit and rammed with a pole, a fresh pit being dug alongside immediately afterwards. In this way a very large number of stainers were killed. The stainers like shade from the sun, and so they may be found under the seed or on a shaded side of the pit. It is important that the surrounding soil should be quite bare of everything for a yard or so, and the earth taken out should be thrown well away from the top; there is then less likelihood of the stainers sheltering near the pit instead of in it. This year they were unusually numerous, and although large numbers of couples were trapped, the numbers in the field increased rapidly as soon as the bolls began to open. Most of the first opening cotton was quite clean, but the percentage of stained cotton increased as time went on. The nights were now becoming chilly, and the immature stainers took to sunning themselves in the early morning in large groups on exposed situations, such as tree stumps. Experiments were tried with a local fish poison as a contact insecticide, which appears to have some value.

Other Pests.—The chief destructive agencies apart from insects and disease were baboons, which did an appreciable amount of damage in stripping green bolls. Rats and field mice ruined a quantity of seed cotton in the fields by dragging it along the ground to their nests to eat the seeds.

The result of the season's working is encouraging, the increase in yield being chiefly due, as it seems to me, to the check offered to the red bollworm.

STATEMENT OF EXPENDITURE IN CONNECTION WITH CATCHING RED BOLL-
WORM MOTHS.

Payments to labour, catching 287 moths	..	..	..	..	..	6s.
Expenditure on trap (carbide and paraffin) (79 moths)	..	..	..	..	..	10s.
20 per cent. of capital cost of trap	..	..	..	..	..	4s.
Cost of catching 366 moths on 5 acres	..	..	..	..	..	£1.
						= 4s. per acre

It has been stated above that the yield was approximately three times the average for this estate for the past six years. But on a very conservative estimate, putting the increased yield at only an extra 120 lbs. of lint per acre, the increased revenue, after deducting 4s. an acre for the expenditure on trapping and catching moths, works out at £3 16s. an acre if the cotton is sold at 8d. per lb.

NIGERIA

REPORT ON THE CORPORATION'S SEED FARM, DAUDAWA, NORTHERN NIGERIA, FOR THE SEASON 1926-27.

BY

J. DAWSON SHEPHERD.

THE Report for 1926 covered the period from the establishment of the farm in January of that year until the middle of September. The present report deals with the work carried out between September, 1926, and September, 1927.

Clearing.—In the intervals between agricultural work, clearing the bush was continued until April, 1927, by which time 100 acres had been added. Twenty acres were also cleared and broken for the co-operation farmers. The average cost of clearing was maintained at about 30s. an acre.

Before the commencement of the cultivation season, a total area of 240 acres had thus been cleared, whilst on the residential site an additional area of bush was cut down, but not stumped, in order to reduce the insect population.

Between the area cleared in 1926 and this year, a strip 88 yards wide has been left, which consists of two fire-breaks next to the cultivated ground, and a wind-break 44 yards wide of original bush in the centre. It is hoped that this strip will provide useful shelter from tornadoes, and also from the dry harmattan winds during the cotton ripening season.

The general cropping scheme in 1926-27 and those proposed for 1927-28 and 1928-29 are given on p. 235 (each field consists of twenty 1-acre plots).

SEASON 1926-27.

Rotation Crops.—Harvesting the 10 acres under ground nuts was very expensive, owing to the early cessation of the rains, and what should have been a profitable crop resulted in a loss, owing to abnormal climatic conditions.

The 20 acres under guinea corn showed a profit of about 18s. an acre, the corn proving extremely useful in feeding the labour on the farm during a time when there was a threat of famine. The yield was adversely affected by the absence of late rains.

The 50 acres of beans sown for green manure were turned in

during November, 1926. This operation was expensive as the ground had become very hard, but by combining it with the preparation of ridges on which to sow the subsequent crop of cotton the costs were divided. The early cessation of the rains will probably reduce the beneficial effects which were expected from this green manuring, but the cotton crop sown on this land already shows a noticeable improvement over that sown on fields which have not been so manured.

				1926-27.	1927-28.	1928-29.
Field	1	..	..	Cotton	Beans	Cotton.
"	2	..	..	Beans	Cotton	Beans.
"	3	..	..	{ Beans	Cotton	Beans.
"	4	..	..	{ Corn		
"	5	..	..	{ Cotton	Beans	Cotton.
"	6	..	..	{ Ground nuts	Cotton	Beans.
"	7	..	..	{ Beans		
"	8	..	..	{ Corn	{ Ground nuts	{ Beans.
"	9	..	..	{ Beans	{ Beans	{ Corn.
"	10	..	..	Not cleared	{ Corn	
"	11	..	..	Not cleared	{ Lubia	Cotton.
"	12	..	..	Not cleared	{ Beans	Beans
"	13	..	..	Not cleared	Cotton	Cotton.
"	14	..	..	Not cleared	Beans	Cotton.
"	15	..	..	Not cleared	Beans	Beans.
"	16	..	..	Not cleared	Cotton	

TOTAL CROP AREA.

1926-27: Cotton, 40 acres; Maicuna beans, 50 acres; corn, 20 acres; ground nuts, 10 acres	..	..	..	..	120 acres.
1927-28: Cotton, 100 acres; Maicuna beans and lubia, 106 acres; corn, 10 acres; ground nuts, 4 acres	..	..	..	..	220 "
1928-29: Cotton, 100 acres; beans, 110 acres; corn, 10 acres	..	..	..	..	220 "

Cotton.—The dryness of last season may have affected the yield of cotton less on the Seed Farm than on native farms, owing to better cultivation and tillage and earlier sowing. The flowering of the first sown cotton commenced on August 12, about six weeks after sowing. When the rains ceased on September 15 (to which date there had been only 5.5 inches as compared with 13.37 inches this season), bolls of any size were few and far between, and practically the whole of the crop had to develop and ripen on a soil particularly unretentive of water. It was, however, fairly free from pests. Boll-worms and stainers were unexpectedly few, and most damage was done by leaf curl. All plants showing this disease were weeded out and burnt in December.

The crop, as was to be expected in recently reclaimed land, was very uneven. The number of formed bolls per stand in November

varied from none to as many as ninety. The majority gave from twelve to fourteen. Picking started on December 13, and was finished with two pickings by January 22. Thirty acres gave an average of 316 lbs. seed cotton per acre. The 10 acres which had been cleared only just before being sown, and on which the soil was exceptionally gravelly, gave a yield of 179 lbs. per acre. Owing to pressure of work it was impossible to weigh the picking, acre by acre, and there must have been a great difference between the maximum and minimum acre yields. There is little doubt that on one or two acres the yield was over 500 lbs. per acre of seed cotton. Comparing this with native farms, there is a record of an acre on one of the latter yielding as much as 400 lbs., but in an average year the average native yield is only about 150 lbs., and last year it was probably under 100 lbs.

SEASON 1927-28.

Cotton.—Fifty acres of the area sown in beans and guinea corn last season were ridged up before the end of January, nothing else being done to this land before sowing in the last week in June. This area, together with 10 acres devoted to ground nuts last year, gave 60 acres of previously cultivated land, and 40 acres of newly-broken land, all under cotton, sown by July 22. The seed rate was 17 lbs. per acre. Resowing was finished by the 31st. Germination, with the exception of a very few patches, was excellent, and stands were thinned out, as last season, to two plants. A week after thinning, the ridges were hoed up with the native hand-plough; hoeing has been the only other treatment of these cotton fields to date. After the rains stop, a second mulching with the hoe will be given.

As the result of experience, the cost of cotton cultivation has been considerably reduced. Last year, from ridging to the burning of sticks and levelling the ridges, it was £2 14s. per acre. This season it should be little more than £2.

There has been a much more marked attack of leaf worm than last year, but leaf curl appears less. All infected plants have been removed.

At the time of writing (end of September), while the cotton as a whole is looking well and more promising than last season, the continuous heavy rains in September are undoubtedly affecting it, and the terminal shoots are not developing healthily. Should the crop recover, as it probably will when the dry weather sets in, a distinctly heavier yield than last year may be expected on the old land, but estimation is hazardous, if not impossible, until the end of October.

Other Crops.—One hundred acres have been sown in Maicuna beans; of these 40 acres were sown on last year's cotton land during the month of May. These beans were hoed in in the first fortnight of September. The crop was a heavy one, and it was calculated that about 9 tons per acre had been hoed in.

The remaining 60 acres were sown on the new land in July and August. This crop will be hoed in at the commencement of the next rainy season in April. The work will then be cheaper on the soft ground, and, in addition, advantage will have been taken of the winter growth, which continues on into late January.

In Field 6 four acres of ground nuts were sown. These were harvested about the end of September. Six acres of beans were sown for seed, and 10 acres with millet and guinea corn.

A field trial of 5 acres has been made of lubia, an Egyptian bean similar to the Nigerian native bean. Unfortunately the seed arrived from Egypt too late for early sowing, and the appearance of the field crop is somewhat disappointing. A further trial of this bean will be made next year.

Buildings.—The second staff house was commenced in September and practically finished about August. This is larger and more substantial than the first house, and also includes a mosquito-proof kiosk.

Under the supervision of the British Cotton Growing Association a ginnery has been erected of corrugated iron on stone and cement foundations carried 2 feet above ground level. In addition to a 40-saw gin, a hand press and a power saw have been installed. As soon as the roads are in a suitable condition, a portable steam engine will be brought out from the nearest point on the railway. This engine will be fuelled with wood from cleared bush which will be cut up by the power saw.

A water tower to take a service tank and two settling tanks have been built of concrete. From the service tank a pipe line will lead to a reservoir designed to take 55 tons of water. Another tank with slightly less capacity is under construction for irrigation purposes on the residential site. From the first reservoir tank a pipe line will lead to a small supply tank near the Co-operation Farms, and from there to the ginnery. When the rains stop a pump house will be erected near the river, about a mile and a quarter from the residential site. A pipe line has been excavated from the pumping station to the service tank. Work on these buildings has been difficult, since all material and water had to be transported a considerable distance.

Labour.—Owing to the bad rains last year there was a great

shortage of food. A very much greater area than usual was in consequence under corn cultivation, and much labour ordinarily available was lacking. In addition, labour contractors on the neighbouring railway construction made a heavy demand on casual labour. At one time it was doubtful whether the programme of clearing, cultivation, and building could be carried out, but, with the unanimous consent of the permanent labour staff, working hours were increased from eight to nine hours a day, and the pay from 9d. to 10d. Women and children were also employed for lighter cultivation, and found very satisfactory, while the situation was much improved owing to the attraction provided by distributing rations of corn and rice every pay day. About 150 rations of 9 lbs. each were distributed at cost price weekly from June to August. This corn was obtained owing to the kindness of Mr. Barry of the Niger Company.

The health of the labourers has been reasonably good, while that of the European staff has been excellent. The smallpox epidemic in the neighbourhood was kept out of the compound.

Climate.—With the exception of the months of March and April, the climate has not been trying, and the fly and mosquito population is comparatively small. Up to July the rainfall this year was less than in 1926, and the incidence unsatisfactory. The rains in August, however, were good, and during September the fall is almost a record, with the result that the roads have become almost impassable.

Co-operation Scheme.—Three farms are ready for occupation, and will be taken up as soon as the various crops ripen. The farmers will harvest for their use $4\frac{1}{2}$ acres of the crop cultivated up to harvest time for them by the Corporation. They will have substantial houses, and a piped water-supply to a tank near the farms will be provided. Next season they will, if necessary, be assisted with labour at cost, and will be encouraged to cultivate on proper lines. Their cotton, sown with the special farm seed, will be ginned and sold with the Corporation's cotton, and the whole price, less expenses, returned to them. With their own consent, a small proportion of this will be retained by the Corporation and dealt out to them in labour or cash next year. It is hoped to double the number of farmers by next season, by which time the prospective owners will have gained confidence in the scheme. It should be recognized that the success of this co-operation, which is in no sense commercial, depends not only on purely agricultural possibilities, but on gaining the confidence of the natives, who are slow to grasp the altruism of the white man's efforts on their behalf. Success is most likely with men who have been for some time in direct contact with Europeans. Two ex-soldiers

of the W.A.F.F., both strongly recommended by the O.C. Depot, W.A.F.F., Zaria, have therefore been chosen from among possible men. The third man is an exceptionally intelligent labourer, who has been working on the farm for over a year. The first cotton crop of these farmers is likely to be a good one and to fetch a good price, and a voluntary deposit of part of its value with the Corporation should be an excellent lesson in saving. Advertisement by the natives themselves, the best of all propaganda, will commence when our farmers find themselves in full possession of their farms, but even then, however, in all probability, a certain amount of hesitation will be shown before other farmers come into the scheme.

Ploughing.—Two good labourers were sent to the Kano Station of the Department of Agriculture for instruction in ploughing. Three pairs of cattle have been purchased, but they are at present at Samaru until measures have been taken to counteract tsetse fly, which appears to be prevalent at Daudawa. In the meantime arrangements are being made by the Department for expert investigation regarding tsetse fly in the Daudawa district. Should it be found, a considerable amount of clearing, which will lessen the chances of infection, will be necessary along the streams in and around the farm.

Cotton Seed.—The primary object of the farm is to multiply up selected seed supplied by the Agricultural Department. In the first year a new selection was not supplied, partly because the field trials of new selections at the Government Farm at Samaru had proved inconclusive, and partly because the Director of Agriculture naturally feared that on new land only a relatively poor crop would be obtained. The question of the arrangements which can be made in future whereby the seed farm can most efficiently achieve its purposes will be discussed with the Director of Agriculture on the occasion of the forthcoming visit to Nigeria of the Assistant Director and Mr. Engledow.

FIJI

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATION, SIGATOKA, FOR THE SEASON 1926-27

BY

R. R. ANSON.

THE Sigatoka Cotton Experiment Station is a new one; it is situated on the Sigatoka River and about five miles inland from its mouth. The river is roughly fifty-six miles long, but it is navigable (to shallow-drafted punts) for about thirty-six miles only, after which a series of diminutive rapids render it unserviceable for traffic.

Cotton is grown mainly on the river flats, though in a few instances some of the more fertile hills have been used. The district possesses the largest consolidated area of suitable cotton-growing country in the islands, and the area selected for the experiment station is fairly typical of the large areas of country in this valley.

The area of the main farm is 27 acres, and two additional pieces of land, each of 5 acres, have recently been acquired for the purpose of the isolation and propagation of selected seed.

The station has been established in order to test new varieties and the merits of different methods of cultivation, and to carry out experimental and research work on cotton generally; but the main object of the station has been to breed up a variety with which it will be possible to replace the existing type (Sea Island), which, in the last few years, owing partly to the fickleness of fashion, has not enjoyed as wide a market as have other varieties that are employed less exclusively in the luxury trades; at the same time the fact that Sea Island may still prove to be the most profitable variety for the grower in Fiji to produce has not been lost sight of. Single plant selections have, therefore, been made from it with a view to improving the length, uniformity, and purity of the existing strain.

Season.—The season, though dry at its commencement, has, on the whole, been an abnormally wet one, 58.18 inches having been recorded throughout the growing period. It will be seen from the accompanying rainfall chart that the season has been anything but ideal for the cotton crop. It resulted in plants growing lank and sappy and putting on more leaves and vegetative branches than is

the case under normal conditions. But in spite of the adverse season the crops in this district have yielded moderately well, and an average of 600 lbs. of seed cotton per acre is anticipated. This should be well above the average of any of the other districts in Fiji, where the lack of sunshine during the critical periods of plant development has greatly reduced the yield per acre.

Selection Work.—One hundred single plant selections were made in various parts of the district, and records were kept of type, habit of growth, early or late maturity, shedding tendency, drought resistance, size of leaf, number of vegetative branches, etc. Particular attention was paid to select plants of an open type, possessing small leaves and as free as possible from vegetative branches, with bolls of full opening character with the point of the burr turned well back. Tracings were taken of the length and diameter of two average bolls from each plant, and these were kept for purposes of record.

Several of the parent plants selected were entirely devoid of vegetative branches, but, unfortunately, none of the progeny have inherited this trait, all of them possessing at least two, and some producing as many as five. This may have been due to cross fertilization having taken place from plants of less desirable characters, or it is possible that, owing to the exceedingly dry nature of the previous season, the vegetative branches did not develop.

With regard to the lint, particular notice has been taken of drag, diameter of fibre or fineness (eye judgment), lustre (silkeness), evenness of length, lint percentage, lint index, and size and character of the seed. Of the original hundred plants fourteen were selected as being the most desirable and planted out on an isolated plot. At the commencement of the season several plants appeared at first sight to be suffering from "sore shin"; this appearance, upon closer observation, was found to be due to small ants, which had apparently been driven, owing to the dryness existing at the commencement of the season, to seek moisture from the stems of the seedlings, and had caused many of them to break off at the ground level, which necessitated resupplying about 10 per cent. of what had originally been an exceedingly good stand. This conclusion was arrived at owing to the fact that the ants ceased to give any more trouble in this direction after the first good shower of rain had fallen, and the plants all made an extraordinary growth and averaged 7 feet in height. Fortunately, this excessive growth did not interfere with their production, and one or two individual plants produced over 200 bolls.

Later in the season the leaves, bracts, and bolls became spotted, and it was feared that an attack of blackarm (*Bacterium malvacearum*)

was developing, caused by the excessive rains, but this afterwards proved to be "Leaf Spot" (*Helminthosporium gossypii*), and only one case of blackarm was recorded in the Sea Island plants at the experiment station throughout the season; this plant was at once uprooted and burnt.

It is interesting to note that, with the exception of that which is grown under shaded conditions, the whole of the Sea Island cotton grown in this Colony is attacked to some extent by "Leaf Spot," although it does not appear to affect the yield in any way.

Six plants from the progeny rows (the particulars of the lint characters, etc., of these are given hereunder) have been selected as being the most desirable, and rows S.17 and S.25 were the most uniform and true to type; they have supplied sufficient seed to enable a 5-acre plot to be planted up in the coming season.

Although most of the progeny have shown a marked deviation in habit of growth, the lint characters have been fairly retentive, and the cotton produced is of excellent quality.

SINGLE PLANT SELECTIONS FROM SEA ISLAND COTTON, 1926-27.

Number.	Length of Staple (Mm.).	Strength of Staple.	Drag.	Regularity.	Body.	Colour of Tuft.	Colour of Fibre.
S.17-1 ..	52.0	Very strong	Good	Fair	Fair	Greenish-brown	Cream, bright and silky.
S.17-2 ..	54.5	"	"	Good	"	Pale greenish	"
S.17-3 ..	55.5	"	"	Very good	Good	Buff	"
S.17-4 ..	55.0	"	Excellent	Fair	"	"	"
S.25-1 ..	52.6	"	"	Very good	"	Light brown	"
S.25-2 ..	51.8	"	"	Good	Excellent	Greeny brown	"

Number.	Colour of Seed Coat.	Size of Seed.	Weight of 100 Seeds and Lint (Grms.).	Weight of 100 Seeds (Grms.).	Lint Index.	Ginning Outturn (Per Cent.).	Number of Bolls per Lb.
S.17-1 ..	Black	Large	19.37	15.30	4.07	26.0	118.5
S.17-2 ..	Dark brown	"	18.94	14.56	4.38	21.0	137.27
S.17-3 ..	"	Medium	18.85	14.04	4.81	26.5	133.5
S.17-4 ..	Brown	Large	20.99	15.76	5.23	27.2	122.5
S.25-1 ..	"	Medium	20.11	14.13	5.98	27.2	129.06
S.25-2 ..	Dark brown	"	20.41	15.34	5.07	30.0	119.98

N.B.—The ginning percentage was in each case taken from 100-gramme samples.

New Guinea Kidney Cottons.—The selections sent out by the Corporation (seed from five single plants chosen by Mr. Evans when in New Guinea), though by no means fixed to any particular type, are proving very interesting, and in spite of the adverse season experienced, some of them have produced as much as 1 lb. of seed cotton per plant, which appears to be rather an exceptionally high yield. They were planted out on an isolated plot at Lawaga, the nearest cotton being well over 1 mile away from them. The soil consisted of a moderately rich brown river silt of great depth and fair drainage. The seed was planted on December 8, 1926, in rows 7 feet apart and spaced to 5 feet between plants, and so laid out that it was possible to cultivate from any direction; the land had been twice ploughed and harrowed, and the seed bed was therefore a fairly good one.

The soil moisture was sufficient to germinate only about thirty plants, and at first it looked as though the bulk of the seed would be lost; however, fairly good rains fell towards the end of December, and, with the exception of four, every seed had germinated by December 28.

K.3 was the first to flower; the plant both in habit of growth and shape, size, and colour of leaf showed a great similarity to Sea Island, and the flower was very similar, although both the petal and corollary coloration varied in intensity; the size of the petals remained fairly uniform. This variety being the first to flower was naturally the first to mature, and picking commenced on June 7, 1927. The lint possesses fair drag and is the longest and finest of the five selections (average length $1\frac{1}{2}$ inches), but the boll is the smallest and does not open so well as the others. On the whole, the plant has more vegetative branches and shows a tendency to lodge. The bract, though much larger than that of Sea Island, was by far the smallest when compared with the other selections. The seed was 94 per cent. free-seeded and 6 per cent. conglomerate as in pure Kidney cottons, conglomerate and free-seeded locks being found on the same bush.

K.1, K.8, and K.11 were much the same in habit of growth and type of plant, all of them possessing large leaves and giving upright, robust plants of open habit. They all appeared to be fairly Jassid-resistant, and reached an average height of 8 feet. The flower colourings varied greatly from a pale yellow open Kidney type with just the faintest trace of red colouring at the base of the petals, to rich yellow with crimson corolla colourings. In K.1 and K.11 the petal lengths varied greatly, as did the lint; both the lint and petal lengths of K.8 selection remained fairly uniform, however; but

whether there is any correlation between the two factors has yet to be proved.

K.24 was badly attacked by Leaf Hopper (a species of Jassid), and in consequence yielded poorly. The flower colouring remained quite consistent on all plants and resembled that of Egyptian cotton. The lint was of very poor quality, badly butterflied, and completely lacking in drag; the bolls were small and did not open too well; roughly, 10 per cent. of the seed was conglomerate.

Four good types of plant were selected and selfed, two from K.3, and two from K.8. These were 100 per cent. free-seeded in all cases.

Samples of lint from K.1, K.3, K.8, and K.11 have been sent to England for spinning tests. It is thought that it may be possible to produce a useful type of cotton from these hybrids.

SINGLE PLANT SELECTIONS FROM NEW GUINEA KIDNEY COTTONS, 1926-27.

<i>Number.</i>	<i>Length of Staple (Mm.).</i>	<i>Strength of Staple.</i>	<i>Drag.</i>	<i>Regu- larity.</i>	<i>Body.</i>	<i>Colour of Tuft.</i>	<i>Colour of Fibre.</i>
K.3-1 ..	35.4	Very strong	Good	Poor	Very good	Grey	Cream and bright.
K.3-2 ..	39.0	Very strong	Very good	Fair	"	"	"
K.8-1 ..	35.2	Very strong	Excellent	Poor	"	"	Rich cream and bright.
K.8-2 ..	35.2	"	"	Fair	"	Brown and pale green	"

<i>Number.</i>	<i>Colour of Seed Coat.</i>	<i>Size of Seed.</i>	<i>Weight of 100 Seeds and Lint (Grms.).</i>	<i>Weight of 100 Seeds (Grms.).</i>	<i>Lint Index.</i>	<i>Ginning Outturn (Per Cent.).</i>	<i>Number of Bolls per Lb.</i>
K.3-1 ..	Dark brown	Medium	17.81	11.53	6.28	35.0	111.25
K.3-2 ..	Chocolate	"	20.47	13.52	6.95	34.0	103.09
K.8-1 ..	Dark brown	Large	22.84	15.01	7.83	35.0	98.43
K.8-2 ..	"	Medium	21.67	14.46	7.21	33.0	99.12

N.B.—Ginning percentages of the above were in all cases taken from 100-gramme samples.

By making constant and systematic selections from good types of the free-seeded variety, it may be possible to get them to breed true to type after a few years, and to eliminate entirely the conglomerate Kidney seed which makes ginning difficult. The cotton



SEA ISLAND SELECTED PLANTS WITH LEAVES REMOVED

The cotton has in some instances been gummed into the dried burr in order to show the approximate number of bolls per plant.



K. 8-1

A selection from the New Guinea Kidney Cotton hybrids.



MEADE COTTON

Showing straggling growth caused by tip-worm attacking terminals.



LOCAL KIDNEY COTTON

Showing habit of growth.

is much more easily picked than Sea Island, and in a moderately good crop an indifferent picker can average 75 lbs. of seed cotton per day, whereas in Sea Island it would be difficult for him to maintain an average of 30 lbs. Small samples of seed from each of the above-mentioned plants were forwarded to the Cotton Research Station, Trinidad, in order that some genetical experiments might be carried out with them.

YIELDS FROM NEW GUINEA KIDNEY COTTONS UP TO OCTOBER 1, 1927,
SEASON 1926-27.

Number.	Number of Plants.	Total Weight of Seed Cotton Picked (Lbs.).	Yield per Acre (Lbs.).
K.1	41	32½	986.4
K.3	42	37	1,096.3
K.8	37	38	1,278.1
K.11	41	35	1,062.3
K.24	37	17	571.7

N.B.—The above results are not final, as there is one more picking to be reaped from all selections, which will most probably increase the yield per acre by 25 per cent.

OTHER VARIETIES.

Sea Island.—Sea Island has, in most cases, given by far the highest yield in both the November and December plantings. The other cottons were attacked each to a greater or lesser degree by the Fruit Fly (*Dacus passifloræ*), a new pest for cotton to contend with.

Korolevu Hybrid.—This hybrid (probably a Caravonica), which showed promise of an exceptional productivity early in the season (some plants producing up to 300 bolls), was very badly attacked by *Dacus passifloræ*, and at least 90 per cent. of the bolls were lost through this and other causes.

Meade.—The Meade cotton has been a complete failure this season; the main causes were attributed to internal boll rot (*Rhizopus nigricans*), Tip Worm (*Earias fabia*), and Fruit Fly. It is doubtful whether Meade or any cotton of the genus *Hirsutum* will ever be a success in Fiji except in very dry seasons, as they do not appear to be suited to the moist atmospheric conditions and the relatively high humidity.

Kidney Cotton.—The Kidney cotton-seed was obtained locally from a plant which had carried over from the early cotton-growing

days in Fiji. The plants averaged about 8 feet 6 inches high, and the wet season made them later in reaching maturity than would have normally been the case, with the result that when the cotton opened it came in for more than its fair share of cotton stainers and pink bollworm, which between them greatly reduced its yield.

The lint was harsh and the staple short and irregular, measuring from $\frac{7}{8}$ inch to $1\frac{1}{8}$ inches.

Pima.—The seed was obtained from Lautoka; it had been stored in an open shed for some considerable time and was badly affected by powdery mildew and anthracnose, and as it failed to give a satisfactory germination, it had all to be ploughed out and was replaced by Meade.

In carrying out comparative tests on these varieties, where sufficient seed was available, each variety was planted out on duplicated $\frac{1}{2}$ -acre plots, and ten plots of each variety, each measuring $\frac{1}{10}$ acre, were arranged on the chessboard system as a check against soil variation.

RESULTS OBTAINED FROM VARIETAL TESTS.

Plot No.	Area (Acre).	Variety.	Date Planted.	First Picking Date.	Cultivations.	Weight of Seed Cotton (Lbs.).	Yield per Acre (Lbs.).
1 ..	$\frac{1}{2}$	Sea Island	18/11/26	28/3/27	5	702	1,404
2 ..	$\frac{1}{2}$	Meade	30/12/26	3/5/27	5	71 $\frac{1}{2}$	142 $\frac{1}{2}$
3 ..	$\frac{1}{2}$	Kidney Hybrids	19/11/26	15/7/27	7	88	176
4 ..	$\frac{1}{2}$	Meade	29/12/26	17/5/27	10	100 $\frac{1}{2}$	201
5 ..	$\frac{1}{2}$	Sea Island	18/11/26	28/3/27	5	522	1,044
6 ..	$\frac{1}{2}$	Meade	31/12/26	17/5/27	6	110 $\frac{1}{4}$	220 $\frac{1}{2}$
7 ..	$\frac{1}{2}$	Kidney	20/11/26	25/4/27	4	238	476
8 ..	$\frac{1}{2}$	Korolevu Hybrid	23/11/26	27/7/27	6	73 $\frac{1}{2}$	147
9 ..	$\frac{1}{2}$	Meade	25/11/26	11/2/27	3	254 $\frac{1}{2}$	509

PLOTS 10 AND 11 (CHESSBOARD PLOTS). (AVERAGES FROM TEN $\frac{1}{10}$ -ACRE PLOTS.)

Variety.	Area (Acre).	Weight of Seed Cotton Picked (Lbs.).	Yield per Acre. (Lbs.).
Sea Island	$\frac{1}{4}$	80	320
Meade	$\frac{1}{4}$	9.935	39 $\frac{3}{4}$
Kidney	$\frac{1}{4}$	103.75	415

N.B.—The above varieties were all planted on December 10, 1926.

CUTTINGS.

A quarter of an acre was devoted to cuttings taken from Sea Island and Kidney cottons. The wet season provided favourable conditions for this class of work. Eighty-six per cent. of the Sea Island struck and made good growth, reaching maturity about sixteen days earlier than is usually the case with plant cotton. The bolls were slightly smaller than those of the plant cotton and averaged 143 to the lb., but the lint did not appear to have deteriorated in any way, and averaged 50 mm. in length, and this season it was, perhaps, stronger and less neppy than that of the plant cotton.

In the case of the Kidney varieties, the cuttings took fifteen days longer to mature than those from the Sea Island; the bolls averaged 109 to the lb. and the lint averaged 1 inch full.

As a means of effecting a rapid multiplication of desirable types of pure line cottons up to commercial proportions, or of obtaining pure seed from desirable types of plants grown next to other varieties in varietal experiments, there is no doubt that this is an excellent method, providing that the climatic conditions are such that a successful strike will be assured.

SPACING EXPERIMENTS.

The following experiment was designed with a view to obtaining some information as to the effect of different spacings on Sea Island cotton at different times of planting.

It is realized that seasonal and soil conditions have had a marked effect on the results obtained, but by conducting the experiment over a series of years some reliable data may be arrived at.

Time and available labour did not allow the experiment to be carried out as thoroughly as it might have been, but it is to be hoped that now that the preliminary work, such as clearing and burning off, etc., has been completed, it will be possible, in the coming season, to conduct this experiment in fuller detail.

Along the rows the spacings adopted were as follows: (a) unthinned, (b) thinned to 2 feet 3 inches, and (c) to 4 feet 6 inches between plants. Rows were spaced to 6 feet in all cases.

The experiments were conducted on $\frac{1}{4}$ -acre plots. These plot measurements were 1 by $2\frac{1}{2}$ chains each, and all rows were $2\frac{1}{2}$ chains in length. The stand obtained was fairly uniform, but plots were not particularly well drained, and after heavy rain, water lay on them for longer than it did on some of the other sections of the station.

The cotton obtained from the unthinned series was inferior to that obtained from the thinned, and the bolls were smaller and did not open so well. Owing to a continuity of wet and cloudy weather, the cotton took longer in reaching maturity than it does under normal conditions, and it was not possible to complete all pickings before October 31, by which time all cotton, according to the law of the Colony, must be uprooted and burnt.

SPACING TESTS ON SEA ISLAND COTTON.

<i>Plot.</i>	<i>Spacing.</i>	<i>Date Planted.</i>	<i>Number of Plants.</i>	<i>Yield (Lbs.).</i>	<i>Yield per Acre (Lbs.).</i>	<i>Means (Lbs.).</i>
13	Buffer row	3/1/27	281	13 $\frac{1}{4}$	583	627.0
	Unthinned					
	2 feet 3 inches					
	4 feet 6 inches					
	Unthinned					
	4 feet 6 inches					
	2 feet 3 inches					
	Unthinned					
	4 feet 6 inches					
	2 feet 3 inches					
14	Buffer row	27/1/27	189	9 $\frac{1}{2}$	418	337.3
	Unthinned					
	2 feet 3 inches					
	4 feet 6 inches					
	2 feet 3 inches					
	4 feet 6 inches					
	2 feet 3 inches					
	Unthinned					
	4 feet 6 inches					
	Unthinned					

TIME OF FLOWERING AND BOLLING AVERAGES.

With a view to ascertaining the time taken between the square, flower, and boll formation of different varieties, one plant of each variety was labelled, and daily observations were made. Five squares were taken, and as each square formed it was marked by a different coloured ribbon, which was attached to the branch directly beneath it.

Constant shedding from various causes gave endless trouble, and in some instances the ribbon had to be changed several times to other squares as they formed (the former ones having dropped off).

The following is a list of averages obtained :

Plot.	Row.	Plant.	Variety.	Days between Squaring and Flowering.	Days between Flowering and Boll Formation.	Days between Boll Formation and Maturity.
6 ..	24	3	Meade	20	2	57
8 ..	3	8	K. Hybrid	23	3	46
11 ..	1	3	Acala	21	2	55
12 ..	21	5	Meade	22	2	53
1 ..	8	7	Sea Island	25	3	51
L ..	4	9	K.8	21	2	52
7 ..	5	4	Kidney	21	2	50
L ..	9	3	K.3	18	2	49

PESTS AND DISEASES.

Pink Bollworm (Platyedra gossypiella).—This insect was present everywhere and in all varieties, but it is not nearly so much in evidence here as it is in most cotton-growing countries. An *Apanteles* has been bred out several times by the Government Entomologist, who is of the opinion that it comes from this host, and its pupa has been found in the bolls, but he considers that its numbers are hardly sufficient to account for the light incidence of the pest. Since his last visit he has obtained a Chalcid, which is an undoubted pupal parasite of *Platyedra*. He is of opinion that both it and certain other pests could be greatly reduced if bolls which abort at the beginning of the season were collected and burnt.

Stainers (Dysdercus insularis).—Despite wholesale collection and destruction, these were very abundant at the station towards the end of the season. They have numerous wild hosts which carry them over from season to season, and they migrate in the adult form to cotton shortly after it has reached maturity, and rapidly breed up. This means that the cotton which first reaches maturity attracts all the stainers of the district, and thus it is that the best cultivated crops generally suffer most. Large numbers of the bugs have been examined for Tachinid eggs, but so far nothing has been discovered. The eggs were found in the soil at depths from 1 to 1½ inches.

Harlequin Bug (Tectocoris lineola).—This was not very abundant, and has been kept in check by making periodical collections by hand. Egg collections have failed to yield parasites, and the entomologist is almost certain that none exist. In his breeding experiments he has discovered that the Harlequin Bug is one of the causes, if not

the sole cause, of a brown stain which had been mistaken for a mineral oil stain and had puzzled many. The brown coloration of the lint is probably connected in some way with the pigment in the seed coat, which has been punctured in its early stages by the stylet of this bug.

Leaf Hopper (a small yellow Jassid) has been found in great numbers this season. Some cottons were noticed to be less susceptible to its attacks than others. It attacks the leaf in all its stages, causing a small yellowish blotch on the under side, which later becomes a reddish brown. The discoloured areas dry up and contract, causing the leaf to curl. One or two of the New Guinea Kidney Hybrid cottons appear to be resistant. Specimens of Jassid have been sent to London for identification.

Fruit Fly (*Dacus passifloræ*).—This was first noticed on a Hybrid (possibly Caravonica), and a further search showed it to be present on the Meade and Kidney cottons, but despite a long and careful search it could not be discovered on Sea Island. The attacked bolls develop a slimy brown earth-coloured rot, but there is no external sign visible. *Dacus passifloræ* has apparently changed its habits to some extent, and was found pupating in the sections of the boll instead of in the ground, and the pupa remained a lighter straw colour instead of turning a dark brown, as is usually the case. It has many hosts in Fiji, and would therefore be most difficult to control.

It is to be hoped that this pest will not assume major proportions in its attack upon cotton; possibly in a normal season it might not make its appearance.

Tip Worm (*Earias fabia*).—This pest was particularly bad in Meade, and 100 per cent. of the terminal branches were affected. These died back, plants became straggly, and their development was retarded. Counts were made on three plants in order to ascertain the losses of squares and bolls due to this cause, and the following results were obtained:

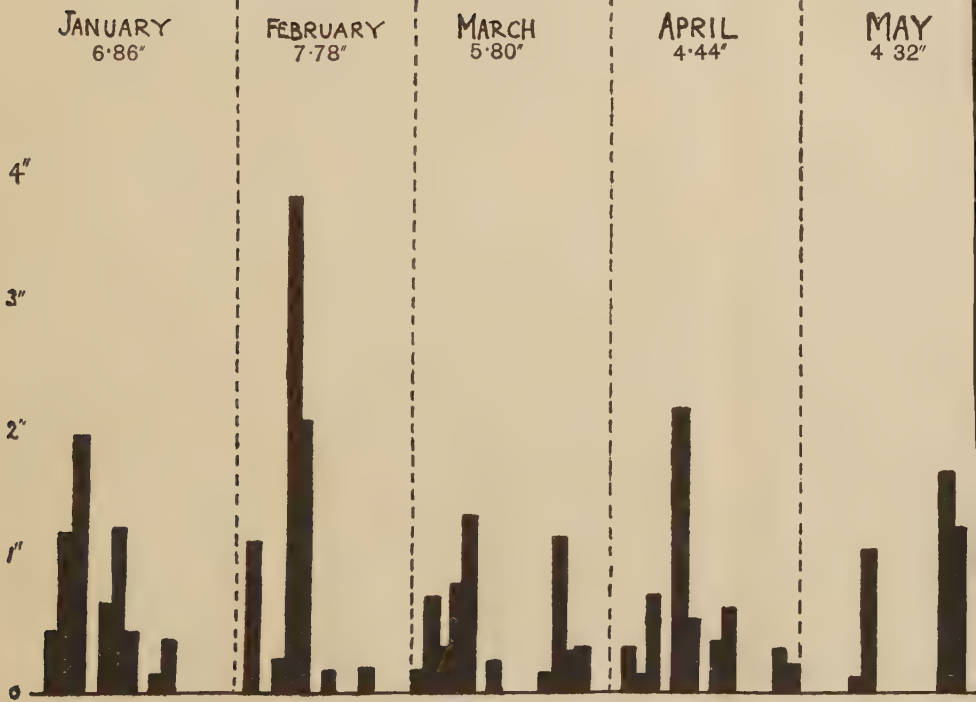
PLANT 1.—*Sea Island* : Squares 8 per cent. due to Tip Worm in 10 weeks; squares 10 per cent. due to other causes in 25 weeks.

PLANT 2.—*Sea Island* : Squares $1\frac{1}{2}$ per cent. due to Tip Worm in 25 weeks; squares 9 per cent. due to other causes in 25 weeks.

PLANT 3.—*Meade* : Squares $11\frac{1}{2}$ per cent. due to Tip Worm in 19 weeks; squares $7\frac{1}{2}$ per cent. due to other causes in 19 weeks.

SIGATOKA EXPERIMENT S

RAINFALL RECORD — SEASON 19



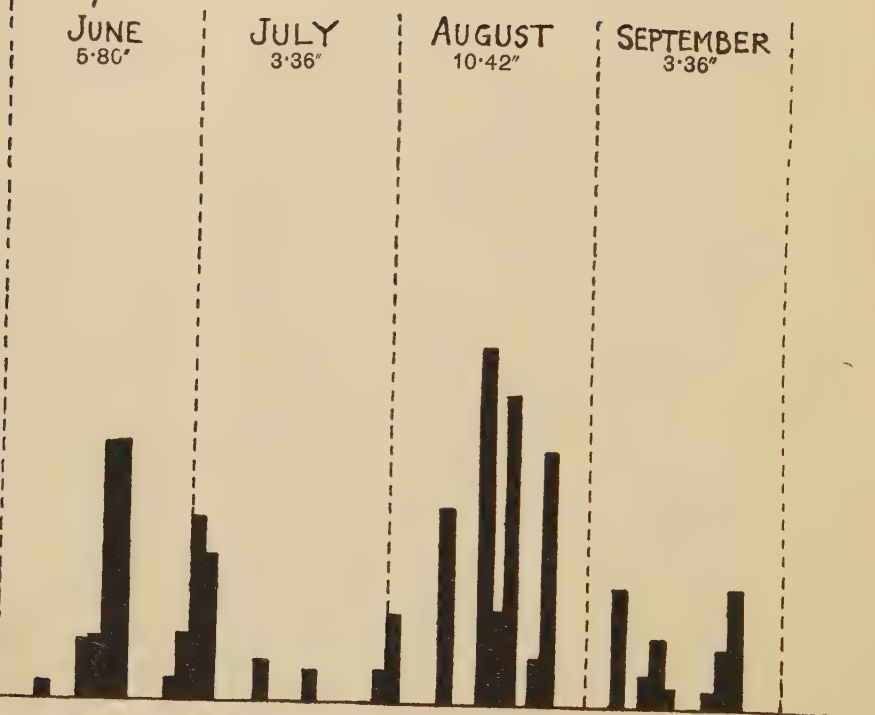
TATION, FIJI.
26-27.

JUNE
5.80"

JULY
3.36"

AUGUST
10.42"

SEPTEMBER
3.36"



CONCLUSION.

No attempt has been made to draw any concrete deductions from the above experiments as, in the first place, the land had not been acquired until late in September, and in the second it would be unwise to base conclusions upon one year's experiments.

I wish to express my gratitude for the generous assistance which has been given me by the Superintendent of Agriculture, the Departmental Staff, the District Commissioner, and my two Field Assistants.

In the programme for 1927-28, which will be an elaboration of that for 1926/27, much more time will be devoted to detail.

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